THE MEAT INDUSTRY

AND

MEAT INSPECTION

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A COMPREHENSIVE ACCOUNT OF THE PRINCIPAL ANIMALS AND FISH, INCLUDING CATTLE, SHEEP, PIGS, POULTRY AND GAME, SUPPLIED TO THE BRITISH MEAT MARKET, TOGETHER WITH A DESCRIPTION OF THE VARIOUS INDUSTRIAL PROCESSES CONNECTED THEREWITH AND THE SCIENTIFIC INSPECTION OF MEAT

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THIRTY-FIVE COLOURED PLATES
ONE THOUSAND ILLUSTRATIONS

VOLUME III

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CHAPTER I

METHODS OF SLAUGHTERING

It is, perhaps, not surprising when one considers the great variation in the animals concerned, and in the civilisations, customs, and habits of those who deal with them, to find a very great variety of methods used for the slaughtering of the various food animals. It is, however, somewhat surprising that in the highly educated and civilised communities of modern Europe there should be divergence of opinion as to the best method to be adopted, and in consequence great diversity of method in actual operation. It surely ought not to be beyond possibility to ascertain, by actual experimenting conducted by thoroughly well-qualified men, what is the most satisfactory method of slaughtering under given circumstances. It ought to follow that *if there be any one method* which can be demonstrated to possess distinct advantages over any other methods, that the former should be made compulsory as far as possible ; but indeed, so long as the whole system of the killing and preparation of cattle, pigs and sheep for the food market is left in the haphazard state in which it is at present, so long will there be all sorts of regrettable discrepancies, of which this is only one example. It is, of course, quite impossible to establish a uniform method of slaughtering so long as the slaughtering itself is allowed to be carried on under all sorts of conditions, good, bad, and indifferent, and it is the remedying of this latter state of things which will have to precede any uniformity in the former.

Fifty years hence one may hope that the author of a text-book on the meat industry and meat inspection will have to describe the one method of slaughtering alone which is recognised as legal, whatever that method may turn out to be, and will only make reference to the others as he would to curiosities of the ancient literature of the subject. We are still far from that condition, however, to-day, and it is therefore necessary to discuss the general principles which should underlie any methods of slaughtering which may be selected, to point out the advantages and disadvantages of adopting this or that procedure, and to describe the various methods which may be seen in Great Britain, and one or two continental methods as well.

General Principles in Slaughtering. Whatever method be adopted to kill an animal which is about to be prepared for human food, the immediate object in view is always the same. That object is twofold. It is, in the first place, to kill the animal as quickly as possible in such a way as to avoid any unnecessary pain to the beast, not to mention any actual cruelty ; and in the second place, to kill the animal in such a way

as will secure that the carcase, when dressed for food, will have what is known as a good keeping quality. If these two results be adequately obtained, the actual mode of operation is of comparatively little importance ; but, as a matter of fact, the various methods which are adopted in slaughtering animals show very considerable differences when estimated by these standards. There ought to be no need at this time of day to insist that any method of slaughtering which is legal must be *expeditious* and *humane*. We, in this country at least, pride ourselves upon the fact that we have passed by some hundreds of years beyond that stage of society which viewed animal suffering with an amazing callousness. There are those who think, and with some reason, that the national temperament is going to the other extreme, with results which might be equally disastrous though perfectly different. Be that as it may, it is quite certain that the mass of the community to-day would not tolerate any method of slaughtering which involved unnecessary suffering to the animals which it is necessary to kill. It seems a curious reflection on our boasted intellectual progress that there should still be found any method of slaughtering which could possess any ethical value, except from the purely humanitarian standpoint to which we have just alluded.

The second important consideration in choosing a method of slaughtering is the effect which that method has upon the keeping quality of the carcase after death. In these days of cold storage, and the infinite number of methods which can be utilised for the preservation of meat for considerable periods of time after the death of the animal, it is of very great importance to know exactly what effect the method of slaughter has upon the keeping quality of the meat.

The Keeping Quality of Meat. The changes which occur subsequent to the carcase having been dressed have been discussed elsewhere, and are those of chemical decomposition followed by the onset of putrefactive processes, and it is the object of the meat-purveyor to get his meat in such a condition that with due care and precaution it will keep in that condition for the longest possible time. Only by doing so can he lay in such a stock as will provide for the food of his customers until the next consignment is available, or tide over a period of weather which might otherwise render much of his meat valueless. Now the keeping quality of any carcase depends primarily upon the amount of blood which is contained in it, since the decomposition and putrefaction processes are largely set up by the presence of different kinds of microbes, all of which require a certain amount of moisture to be present in order that they may carry out their work, and in many cases their activity is exactly proportional to the amount of moisture present. The source of the moisture in the animal body is blood, and it therefore follows, other things being equal, that the method of slaughtering which renders the carcase most free of blood, and that as quickly as possible, is the method which makes best for good quality of keeping. Blood, like other fluids, very rapidly decomposes, and, as may be readily demonstrated in the carcase of any warm-blooded animal, putrefaction will set in very quickly

under ordinary conditions of climate if the blood be left in the vessels. As examples of this, we may observe this process taking place constantly in game and rabbits and other small animals, which are not bled in the ordinary sense of the word. It is, of course, true that meat which contains the blood of the animal from which it was derived possesses a *higher food value* than meat from which all the blood has been extracted, but it is at the same time true that this extra nourishment is obtained at the expense of the keeping quality of the meat in question. It is, therefore, absolutely necessary, in the case of large animals which have to be kept for a considerable time in order that the meat may become sufficiently tender and palatable, that the blood must be extracted, even though thereby there is some diminution in the actual food value of the meat.

Average Quantity of Blood. In most of the warm-blooded animals used for the purpose of meat-supply the average quantity of blood in their bodies is estimated at one-thirteenth of the total weight of the body ; but it must not, however, be supposed that it is possible to remove this total weight even though a carcase is thoroughly well bled. There is always a certain amount of fluid which remains in the minute vessels, and in some of the veins, of both the muscles and the organs of any animals slaughtered in the ordinary way. This amount, however much remains, is not sufficient to interfere with the general result aimed at, namely, the good keeping quality of the carcase ; and, indeed, it may be so slight in amount as to be difficult to obtain, if required for purposes of examination. In a well-bled carcase, if an incision be made by a knife in the musculature, there should be no sign of bleeding. Many investigations have been made with a view of estimating the total quantity of blood found in slaughtering, as well as to discover the conditions which account for those variations. According to Heissler these variations are very considerable ; but, apparently, the age of the animal was not a factor which contributed to that. Sex seems to have some influence in so far as male animals give a larger quantity of blood than female, and the condition of the carcase as regards fat, in his opinion, was of considerable importance ; for he points out that in swine—in which fattening is such a marked characteristic—the fatter the pig, the less was the quantity of blood obtained. The following are some of the percentages of blood-weight quoted :

Cows	from 4.2	to 5·75	per cent.
Calves	,, 4·4	,, 6.67	,,
Sheep	,, 4·37	,, 7·56	,,
Swine	,, 1·45	,, 5·75	,,

Bleeding the Carcase. Signs of Imperfect Bleeding. The bleeding of the carcase is one of the conditions to which the meat inspector pays particular attention in forming his judgment of the fitness, or otherwise, of it for food ; and particularly is his attention drawn to the condition of the blood-vessels in those animals which have *died* first and then been bled afterwards, in which cases the bleeding is always more or less imper-

fect. Unscrupulous dealers will often attempt to pass off an animal which has died suddenly from various causes as one which is fit for food, but the competent inspector can always frustrate such efforts from his knowledge of the fact that bleeding in such cases is always imperfect. Even though the larger vessels may be emptied of their blood, the fluid remains in the *minute veins*, especially just under the skin ; and the same condition gives rise to a darker coloration of the meat than is found in a well-bled animal (*see* Plate XV.). In these cases, too, the condition of the internal organs frequently gives the clue to the inspector that death was not due to the slaughtering but to some diseased condition, of which, perhaps, the evidence is most commonly found in the congested state of the liver. It should also be remembered that in many cases of morbid conditions, in which the animals are brought to the slaughterhouse alive, and there slaughtered, the bleeding, even though the slaughtering is carried out in the ordinary way, is far from satisfactory, and the question then arises whether or not the carcase should be passed as fit for human consumption. In determining this question, the inspector will be guided by the changes which take place in the carcase during the twenty-four or forty-eight hours after the bleeding has been performed, as well as by the colour and consistency of the meat itself.

Causes of Insufficient Bleeding. As a general rule, it may be said that any condition of an animal which lowers the action of the heart, or in which that action is abnormally weak and the blood-pressure consequently much reduced, will result in bleeding being insufficient. Such cases occur as the result of actual disease, but also very frequently are the consequence of sheer fatigue on the part of the animal, which may have been driven a long distance before reaching the slaughterhouse, or may have been compelled to travel too quickly on the road.

All these cases of exhaustion interfere with proper bleeding. The signs are very much the same no matter what the cause, unless it be actual anæmia, namely, the abnormal amount of blood present in the vessels, particularly the small veins, and very frequently the condition of the liver.

Actual Methods of Slaughtering employed. The various methods of slaughtering which are in use at the present day may be classified into two groups, namely, those in which the animal is stunned by some means before being bled, and, secondly, those methods in which a primary stunning is omitted.

A complete classification of these methods may be seen in the following table :

(*a*) With previous stunning .	(1) Hammer, mallet, or club. (2) Pole-axe. (3) Shooting instruments, *e.g.* : Greener's. Behr's. R.S.P.C.A.'s. Ordinary rifle. Other shooting apparatus.

(b) Without previous stunning . { (1) Jewish method.
(2) Throat-cutting, sticking of pigs, sheep, and calves.
(3) Pithing of medulla by knife driven into neck.

Stunning of Animals. It will readily be admitted that from the humanitarian point of view it is always desirable, where possible, to take

FIG. 1.—SLAUGHTERING MALLET FOR SMALL ANIMALS

some means of destroying the consciousness of the animal before the operation of bleeding is performed. How that stunning is carried out is a matter of secondary importance provided that it be immediate and easily performed. As a matter of fact, a great many methods are in vogue. Thus we find in some cases a hammer is the instrument employed (Fig. 2); in the case of small animals a mallet, or a club, may be used (Fig. 1). Other more complicated instruments are also used and will be subsequently described. The important point is that the loss of

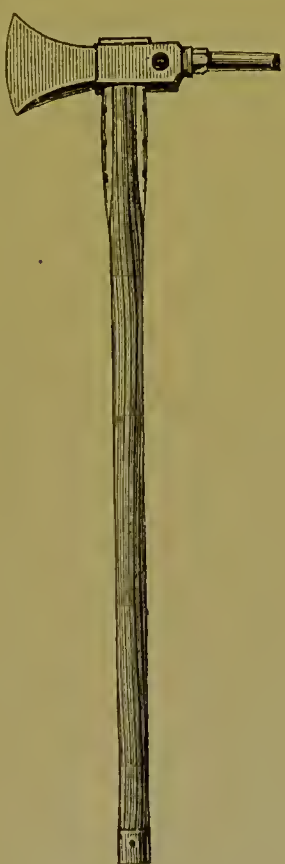


FIG. 2.—GERMAN SLAUGHTER HAMMER

FIG. 3.—STUNNING APPARATUS FOR SMALL CATTLE (GERMAN)

FIG. 4.—SMALL BLUNT SLAUGHTER HAMMER (GERMAN)

consciousness should occur at the earliest possible moment in order that bleeding may be performed as quickly as possible, which again in its turn ensures the setting of the carcase as soon and as perfectly as can possibly be attained. In the case of small animals the means used for stunning are also the actual means of death ; and in some places, as in Berlin, for instance, it is the custom for cattle and hogs to be killed almost entirely with the head of an axe or a hammer. In all these cases great care should be taken that the operator is a skilled person, as nothing is more repulsive than to find a clumsy workman who requires repeated blows to attain his purpose. In some of the more elaborate methods,

Fig. 5.—Bolt Apparatus for Pig-killing (German)

Fig. 6.—Striking-bolt Apparatus for Sheep (German)

Fig. 7.—Spring-bolt Apparatus (German) for Pig-killing

for instance in the instruments which are devised for shooting cattle, the animal is not merely stunned before bleeding but killed outright, and this also applies to the use of the pole-axe and the process of pithing. In every slaughterhouse where the use of the hammer or pole-axe is the custom, there ought to be means provided for a preliminary training of those whose business it is to use these instruments.

Should the Medulla Oblongata be destroyed before Bleeding ? There is a good deal of difference of opinion amongst various writers on the methods of slaughtering as to the effect produced on the completeness of bleeding which follows the destruction of the medulla. It is to be remembered that this part of the nervous system is the seat of all the principal vital centres, and, in particular, those which control respiration, the cardiac actions, the vasomotor arrangements and muscular contractions. Physiologically, therefore, it would appear that by taking any steps which will impair the integrity of the medulla to the extent of destroying all these centres, there must of necessity follow considerable interference with those processes which ensure a complete loss of blood from the tissues. Thus the heart's action is stopped, the respiratory movements cease, and all the muscular contractions which assist in the thorough emptying of the blood-vessels are absent, at least those which are the result of struggling.

Looked at from this point of view, namely, that of physiology, it

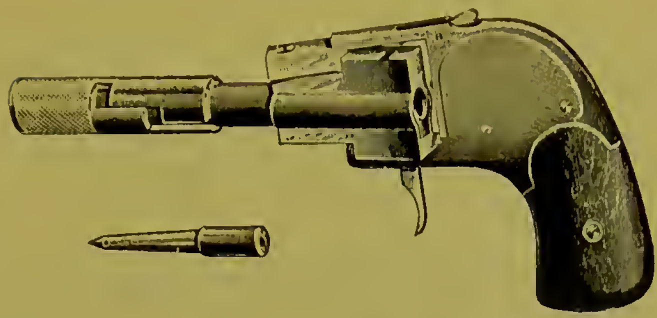


FIG. 8.—SHOOTING-BOLT APPARATUS (GERMAN)

would appear that the most perfect bleeding would be obtained by a method of slaughter which first of all abolishes consciousness by a preliminary stunning, during which unconscious period bleeding should be performed. In that way one of the main objects of the slaughter, namely, the obtaining of a thorough bleeding, would be secured while the humanitarian aspect of the process is not lost sight of. Ostertag is of opinion that after the use of the killing-axe or slaughter-mask, not only is the cerebrum and also the medulla oblongata destroyed by the introduction of the rod, but bleeding is also checked in a manner like that which occurs, as already mentioned, in shooting animals.

Compulsory Stunning advocated. In spite of these considerations, there is still a tremendous amount of slaughtering done without any previous stunning of the animal whatsoever, and this applies particularly to sheep and pigs and calves, in the methods used both in this country and abroad. It is very difficult, indeed, to justify on any grounds, except possibly the loss of time involved, this state of affairs, and the present writer would urge that in all these cases the animals should be first stunned before being bled. It ought to be compulsory in all civilised communities to stun all the higher animals used for food purposes before they are subjected to the bleeding, and it is very much to the credit of some places, notably in parts of Sweden, that this is the rule carried out. The time lost by the simple delivering of a blow upon the head in the

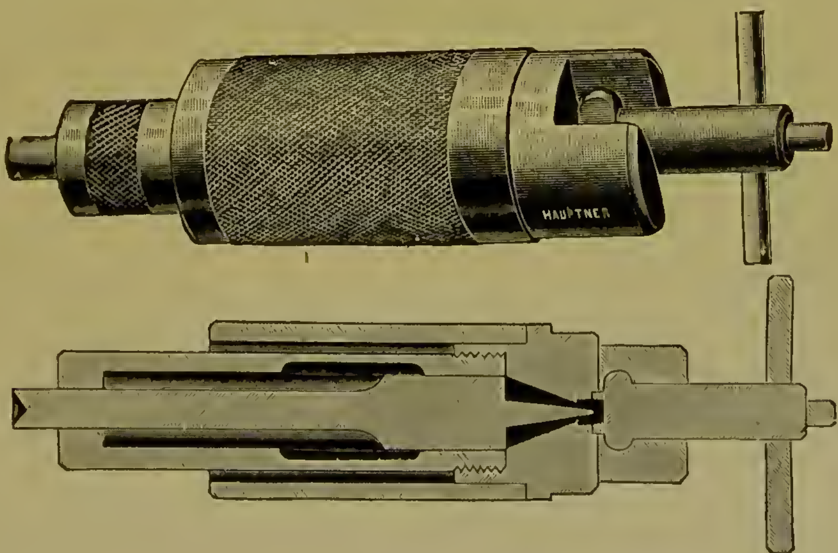


FIG. 9.—SHOOTING-BOLT APPARATUS (GERMAN)

case of calves and pigs and sheep is very trifling, and is more than counterbalanced by that which is gained owing to the absence of the severe struggling of the animal which immediately follows it ; besides, humanitarian considerations ought to make the question beyond dispute. The most prominent exception to the stunning of animals before bleeding is, of course, to be found in the Jewish method which is described elsewhere, but so strongly was this method objected to on account of its cruelty that in some portions of the Continent the method was made illegal ; and, indeed, in Saxony and Meiningen the regulations for slaughtering compel stunning in the case of all animals, the only exception being the fowl. In Saxony and in Switzerland the Jewish method is prohibited. It cannot be seriously maintained that the previous stunning of the animal

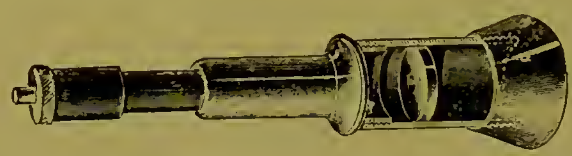


Fig. 10.—Stoff's Shooting Apparatus (German)

interferes to any considerable extent with a thorough bleeding of the carcase, and this being so, it is very difficult to understand why it should not be enforced in every case.

Choice of an Instrument for Slaughtering. If we assume that there is the proper anxiety to select the best possible means for slaughtering animals, the question then arises for consideration what instruments are available for that purpose and which is the most suitable of them all. The decision upon this point would obviously depend upon how the instrument in question meets the requirements of a safe, speedy and efficient appliance, and one which at the same time ensures that there shall be no unnecessary suffering inflicted upon the animal. It is greatly to the credit of the Royal Society for the Prevention of Cruelty to Animals that they have for many years directed the attention of the public to the unnecessary cruelty and suffering which go on as the result of inefficient instructions of slaughterers and clumsy methods, and it is not to the credit of our country that so little attention has been paid to this subject by those in authority. As in many other matters, so in this it has been found difficult to arouse any great attention to the subject. It is doubtless one of those matters which, in the near future, when the whole subject of meat inspection and slaughterhouses is likely to be placed upon a far more scientific and uniform basis, will then receive proper attention. The following facts, however, should be borne in mind ; they are duly set forth in a pamphlet published by the Royal Society for the Prevention of Cruelty to Animals, which may be had on application to the secretary.

Some time ago a committee was appointed by the Admiralty, and this committee made detailed investigations into the subject and issued a report dealing with the most humane methods for the slaughtering of animals. They also made certain recommendations which, if carried

out, would do very much to bring about the desired result. As regards the slaughtering itself, the committee came to the conclusion that the pole-axe, when used by an expert, is, on the whole, the most satisfactory instrument of slaughter; but to this they added a very important qualification to which sufficient attention has not been paid, namely, that in coming to this conclusion, "they must add that in the hands of a nervous

FIG. 11.—R.S.P.C.A. HUMANE KILLER

or inexperienced man the pole-axe becomes an uncertain weapon and may be productive of much suffering." It is just this question of experience, and inexperience, which lies at the bottom of the whole question, and it is to protect the animals from suffering at the hands of the inexpert and inexperienced that efforts should be directed. It is only right to say that in all our slaughterhouses, where many hundreds of cattle are dealt with day by day and week by week, the men who are engaged in killing them do become in every sense of the word experts at their work. It is far different, however, when we come to small slaughterhouses owned by individual butchers, and where the number of animals dealt with is only a few per week, for there can be no doubt that in these places there is a considerable amount of what can only be described as sheer brutality.

Killing by Shooting. Probably most people will agree that by far the quickest and least painful way of slaughtering animals is by shooting

them, a method which is very extensively adopted on the Continent, and it would appear that the objections taken by butchers to this method of slaughtering are chiefly that most of the shooting instruments require the further process of pithing the animal to be performed, which, therefore, loses a certain amount of time ; and time, in a slaughterhouse, means money. With a certain number of the shooting instruments reflex movements continue for some time, even though the animal has been rendered totally unconscious. In order to overcome this difficulty—because, of course, further operations cannot be carried out until violent movements have ceased—the brain has to be destroyed to a further extent than by the mere shooting process. This is done by the pithing process, in which a cane is passed through the hole made in the skull by the pole-axe, the cane being then twisted round several times, thus destroying the brain, and the violent movements of the animal thereupon quickly cease and the slaughterer can then at once proceed with his work. It is obvious, therefore, that in any instruments of the shooting type considerable time will be wasted if the operation of pithing has to be performed afterwards. A further objection applies to most shooting appliances, namely, that the operator finds it necessary to stand in front of the animal he is about to shoot, a position which some cattle resent, and which is apt to cause them to be excited and restless. This applies particularly to the better bred and highly fed cattle which we encounter in the markets in this country.

In some countries abroad there seems to be no difficulty in this matter. In the slaughterhouse at Gothenburg in Sweden, for example, the present writer watched the slaughtering of cattle there for many weeks and did not see a single case in which there was any difficulty whatsoever, even though the operator stood directly in front of the animal and used a shooting appliance. But there is a great difference in the Swedish cattle and the British cattle. The former offer no difficulty whatsoever in being handled at the slaughterhouse and remain perfectly quiet under all circumstances, whereas in British slaughterhouses, as every one is aware, our cattle are often extremely wild and difficult to handle. Fortunately, however, the cattle do not so much resent a person standing at their side, under which circumstances they will often remain perfectly quiet, thus avoiding any danger to the operator and those around him. For all the above reasons it was thought desirable to devise some instrument which would, in the first place, be capable of being used by the operator standing at the side of the cattle instead of in front, and, secondly, which would fire a bullet of such a size that the aperture made in the skull would allow of a cane being passed through it and the operation of pithing being immediately performed. The instrument known as the R.S.P.C.A. Humane Killer has been introduced to meet these conditions and difficulties.

The R.S.P.C.A. Humane Killer. By the courtesy of this society we are enabled to reproduce illustrations showing the operator in the act of using this instrument, as well as the details of its construction and

method of use. The instrument is described as follows: "The R.S.P.C.A. Humane Killer consists of a short revolver-barrel, A, placed at right-angles at the end of a wooden shaft, B. A square-shaped extension, C, is fitted at the end of the barrel to enable the operator correctly to place the instrument in position. A wire runs down the centre of the shaft from the hammer G, terminating at D. At E a lever is placed, which

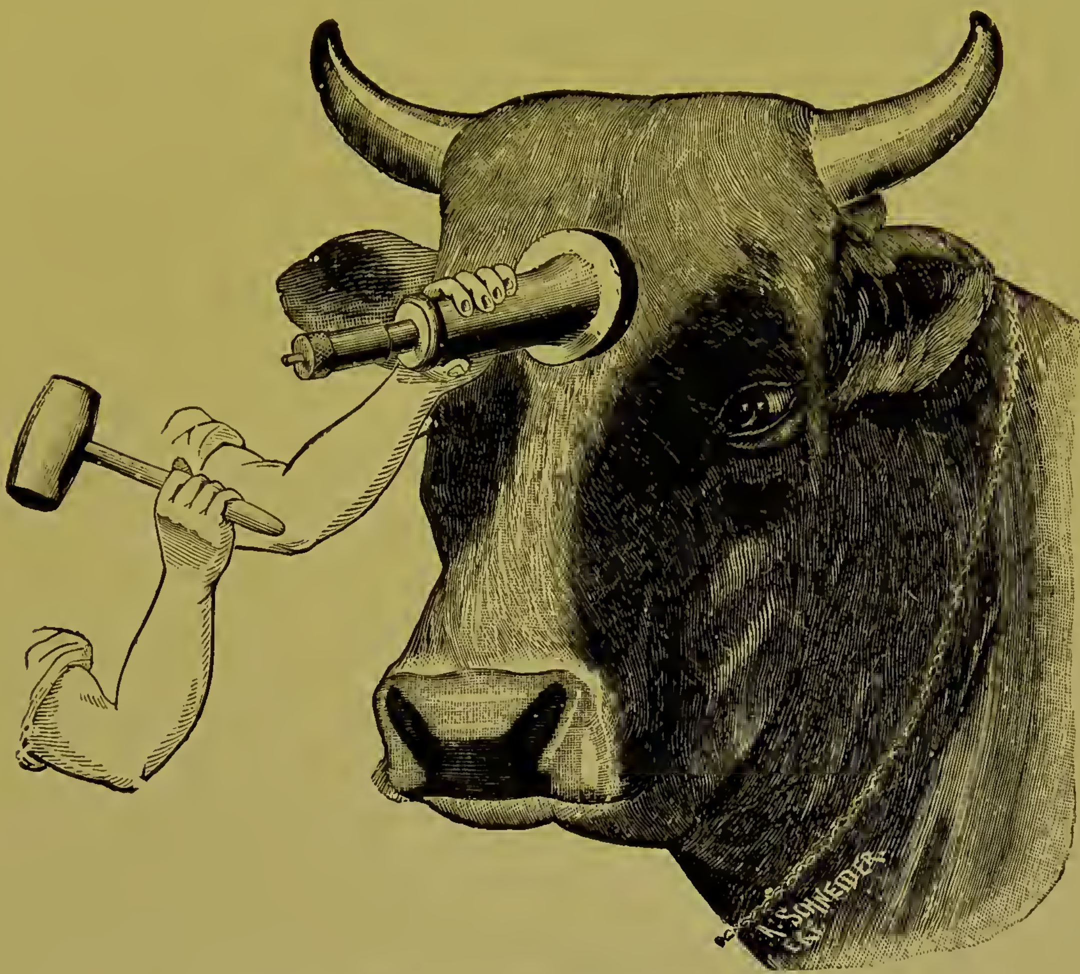


Fig. 12.—Shooting Apparatus for Large Cattle

locks the barrel in position. An extractor is fitted at F to remove the fired cartridge (Figs. 11, 13, and 14).

"Directions for Use. *To Load.* Turn the lever E downwards, remove the barrel A by twisting it a quarter of a turn from right to left and pulling it out. Insert a cartridge in the barrel and replace the same by placing the extractor in line with the lever, forcing smartly home and turning from left to right. Take care that the lever E is pressed well back into position after loading and before firing.

"*To Fire.* The operator faces in the same direction as the animal, cocks the instrument by pulling back the hammer G, then places the extension C on the animal's forehead about half-way between the eyes and top of the forehead and in a direct line with the spinal column. The hand farther away from the animal should grasp the shaft in such a manner that the thumb or forefinger can be placed through the

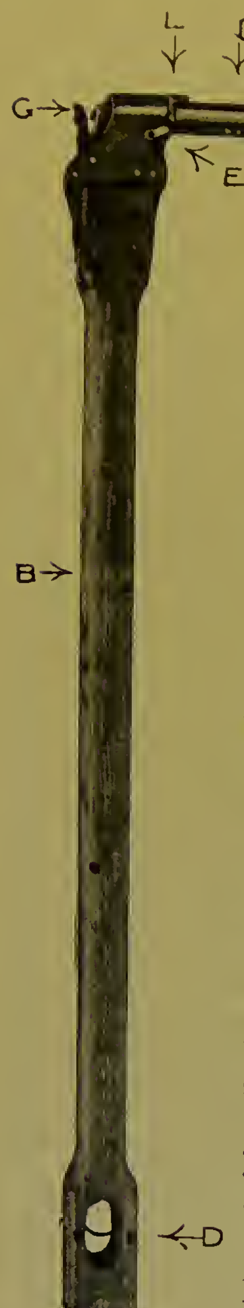


Fig. 13

ring at D. When ready, the hammer is released by a steady pressure on the ring towards the butt of the shaft. The bullet is always found in the animal's head.

" *To Reload.* Take off the barrel as above described, remove old cartridge by forcing the extractor upwards, insert new cartridge and replace barrel.

" *To Clean.* Take off the barrel as above described, and clean with the 'pull-through' in the ordinary manner.

" *Cartridges* can be obtained from any gun-maker. Order the .450 revolver smokeless. Price about 5*s.* 6*d.* a hundred.

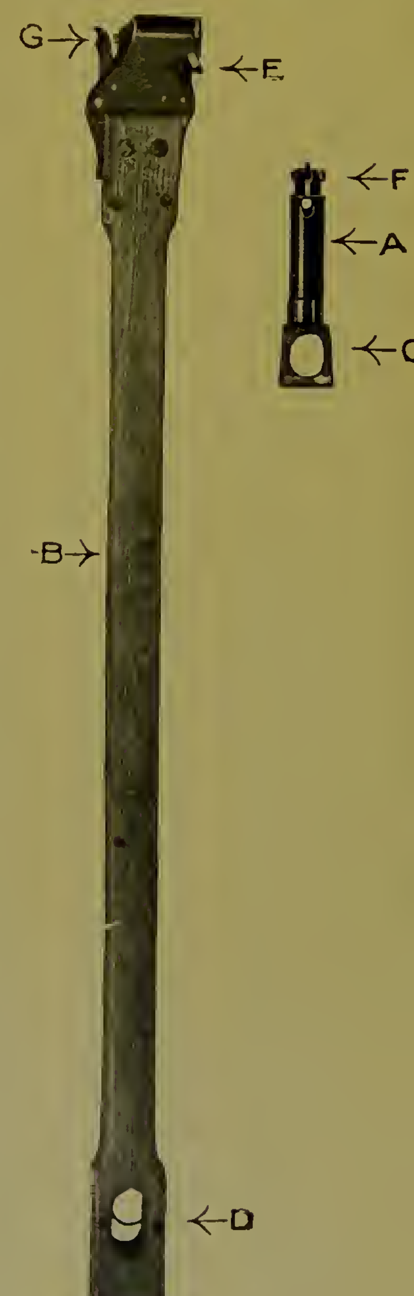


Fig. 14

" *Note.* The Humane Killer is intended for killing large animals *only*, such as horses, bulls, oxen, heifers, and large pigs (old sows and boars).

" *On no account* should it be used for calves, sheep, ordinary pigs and smaller animals. *No gun licence is required* for the *legitimate* use of the killer in slaughterhouses or in killing mortally injured animals in the streets or elsewhere."

Expert Report on the R.S.P.C.A. Humane Killer. In order to place expert opinion on this matter before the general public and the veterinary profession, a trial of this instrument was made at the Islington Market in the presence of William Hunting, F.R.C.V.S., F. W. Wragg, F.R.C.V.S., and the late James King, M.R.C.V.S.—names which are sufficient to guarantee the importance of any opinion given.

Their report was as follows: " On March 13, 1907, we had an opportunity of witnessing a trial of this instrument at the Islington Market, and of estimating its value as a factor in the humane slaughtering of animals for food.

" The usual method of producing insensibility in cattle, as the first step in slaughtering,

is to perforate the skull by a blow from the pole-axe. Properly performed, this act puts an end to all consciousness and feeling, but it does not destroy reflex movements, which are a danger to the men and an obstruction to the proceedings necessary for bleeding and skinning. The pole-axe is therefore followed by the insertion of a cane into the opening made in the skull, and the cane reaches and destroys the back portion of the brain which presides over reflex movement. The pole-axe produces insensibility, and the cane destroys involuntary movement which would otherwise persist for some minutes.

"The pole-axe and cane, used by experts in daily practice, are unobjectionable, but misdirected blows sometimes occur, as also do blows of insufficient force. In the one case the brain is not reached, and in the other useless wounds are inflicted. In the hands of unskilled persons the pole-axe may fail and its use add pain to the circumstances of slaughter. Even greater objections exist to the use of the blunt hammer, which is still used in some provincial slaughterhouses.

"Just as the pole-axe is a great advance on the blunt hammer, so would an instrument which possessed efficiency in unskilled hands be an advance upon the pole-axe. Many inventions have been introduced to displace the pole-axe, but so far with little success. In the horse-slaughtering establishments of London the pole-axe has ceased to be used, and 'Greener's Killer' has supplanted it; but with horses there is not the same urgency to bleed the skin, and therefore no necessity to stop reflex motions; the men can wait.

"With an ordinary rifle the user must stand in front of the animal, a position which the victim resents. Then the aim must be perfect, and the danger of a stray bullet is always present to every person in the slaughterhouse.

"*Requirements of a Good Instrument.* The requirements of an efficient and safe appliance are:

"(1) That it should allow the operator to stand at the side of the animal, and enable him to place the instrument exactly upon the spot where perforation is required. (2) That it will instantaneously injure the brain to an extent ensuring immediate and lasting insensibility. (3) That it will either itself cause loss of involuntary motion or permit the use of a cane to effect that result. The R.S.P.C.A. Humane Killer more nearly conforms to all these requirements than any other appliance we have seen. Used on heifers, cows, and oxen, it is easily applied by an unskilled man, produces instantaneous insensibility, and permits the passage of a cane through the perforation made in the skull.

"But in the case of a very large bull the cane could not be used owing to the enormously thick skin and the mass of dense fibrous tissue surrounding the frontal bones. Even in this case, however, the gun produced immediate and lasting insensibility, which would not always have taken place with the pole-axe, because frequently more than one blow is required to penetrate the thick skull of the bull. The R.S.P.C.A. Humane Killer never fails to penetrate; and for producing unconscious-

ness in the ordinary animals used for food we consider it the most efficient, simple, and safe appliance we have seen for use in a slaughterhouse."

In addition to this opinion, this instrument has been tried in a large number of slaughterhouses in the country, and a great many high opinions of its efficiency have been published ; and, in the light of the above, it seems that those whose business it is to decide upon the methods of slaughtering used should at least insist upon some such instrument being tried with a view to meeting all the demands of a safe, speedy, and humane slaughtering method.

The Pole-axe. This instrument is extremely widely used in this country, and in the hands of a really expert operator it is astonishing how quickly the animal is killed, and how very seldom the aim is missed. Its exact form varies a little, but the illustration (Fig. 15) shows a very common shape in use. The part of the weapon which is the actual killing structure is the elongated iron bar at the back of the axe. The handle usually consists of ash, or hickory; and, *when properly used*, this instrument never fails to produce immediate unconsciousness in the animal. The hole made by the penetrating portion is sufficiently large to admit of the pithing-cane, which is applied directly the axe is withdrawn.

Using the Pole-axe. When a large animal is about to be killed, it has first of all to be immovably fixed before the operator strikes his blow with the pole-axe. To effect this, a rope is passed round the base of the horns, and the other end is then passed through an iron ring which is usually fixed on the wall of the slaughtering-booth close to the floor. The slaughterer and assistants pull on to the free end of the rope, passing through the ring until the animal is dragged so far forward that its nose almost touches the ring itself. In this way the head is kept quite steady. The blow is then struck by the operator, and, if accurately aimed, the point of the pole-axe penetrates the skull and the animal falls, instantaneously unconscious. Thereupon the pithing is performed by the piece of cane which is passed through the hole, right through the brain substance, through the medulla as far as the spinal cord ; and after a few muscular movements the animal remains perfectly still and is immediately ready for bleeding. The vessels in the neck are then severed, and the large quantity of blood which immediately flows ought to be received in special utensils provided for the purpose. It is at once obvious that the satisfactoriness, or otherwise, of this method of killing depends upon the accuracy of aim on the part of the operator. One could hardly imagine a more repulsive sight than that afforded by an operator who requires to inflict several more or less ineffectual blows before attaining

FIG. 15.—POLE-AXE (BRITISH)

his object. In certain continental slaughterhouses there is a special apparatus provided upon which those who are learning the business are compelled to practise, and this ought to be made compulsory wherever pole-axeing is the method adopted. The spot at which the operator aims is shown in Fig. 26, and this point is obtained by drawing lines from the base cf the horn to the opposite eye, the intersection of which lines gives the point aimed at. (*See* Diagrams, pp. 758 and 759.)

Killing-mask for Cattle. In order to obviate some of the mistakes and difficulties which may arise in the use of the pole-axe, various appliances have been invented from time to time with a view to obscuring the sight of the animal. One of the best of these takes the shape of a strong leather mask which is fixed round the horns of the beast to be felled and, when in position, covers the forehead and the eyes. In the centre of this mask there is a steel plate, and through this is a metal tube which acts as barrel for a steel bolt, the latter of which has an enlarged rounded head with a somewhat pointed end. A chain is attached to the bolt to prevent its being severed from the mask. Figs. 16 and 17 show the mask fitted to the head of an animal with the bolt in position. If correctly fitted, the point of the bolt should rest exactly on the vulnerable spot, so that when the operator inflicts the blow upon the head of the bolt it penetrates the skull in the usual position. The bolt is then withdrawn and the mask removed, and the operation of pithing follows just as if the ordinary pole-axe had been used. This apparatus answers its purpose fairly well in many cases, but is open to the serious objection that it is extremely difficult to get it fitted on when dealing with wild and furious animals. Moreover, unless it be fitted accurately the bolt penetrates in a wrong situation. In time, too, the point of the bolt wears away and becomes so blunt as to penetrate the skull with difficulty, and the various parts of the apparatus become loosened from wear and tear. From all this it follows that the using of the killing-mask has not obtained a very wide vogue in this country, though none of the difficulties above mentioned are such as cannot be overcome.

Brunneau Mask. Another form of killing-mask is that known as the Brunneau Mask, which is another leather apparatus used to cover over the eyes of the cattle which are about to be killed. It is very similar to the one just described, and is used to a considerable extent in various slaughterhouses on the Continent. It has the same advantages and disadvantages as we have already mentioned (Fig. 18).

Greener's Humane Cattle-killer. Another of the instruments of the shooting class which has been devised is the well-known Greener's Humane Cattle-killer. This ingenious invention, which has met with a good deal of favour, is an explosive apparatus, almost noiseless, which consists of a short rifle-barrel with a chamber which receives a small cartridge loaded with smokeless powder, and containing a steel-pointed bullet. As the illustrations show, the end of the instrument, which is placed in contact with the skull of the animal, consists of a bell-shaped chamber which deadens the sound, and through which the bullet is directed through the

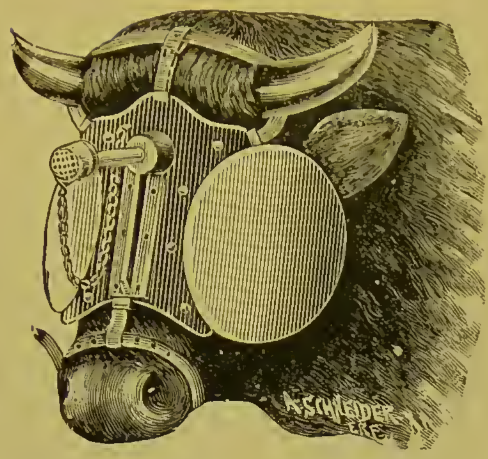


FIG. 16.—KILLING-MASK FOR CATTLE, WITH CHAIN ATTACHMENTS TO THE BOLT

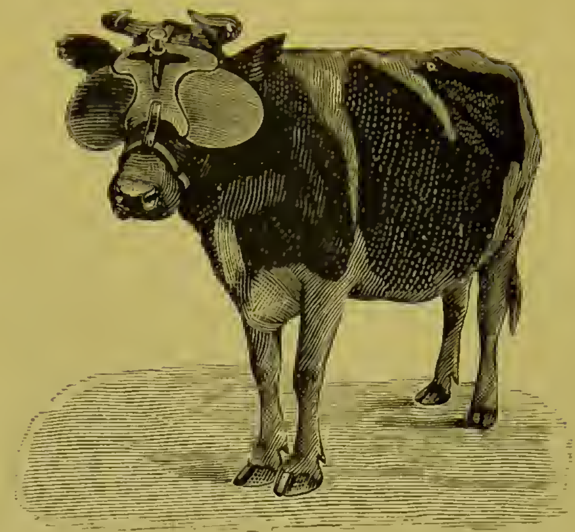


FIG. 17.—KILLING-MASK FOR CATTLE, SHOWING THE APPEARANCE WHEN ATTACHED TO THE ANIMAL

brain to the spinal cord (*see* Fig. 20). What is termed the "original model," for general use in slaughterhouses and wherever cattle are slaughtered on a large scale, is a strong instrument which will stand a good deal of rough usage. In addition there is a smaller form known as the "pocket model," which is made to shut up into a small space, measuring, as it does, five and three-quarter inches in length and weighing about twenty-four ounces.

Method of using Greener's Cattle-killer. The method of using the Greener Killer is as follows :

The cap which contains the firing-pin is unscrewed, which allows the cartridge to be inserted in the chamber. The cap is then screwed up. There is a safety loop attached which should be kept over the striker until ready for use. If the animal is at all restless or cannot be got into the position required, it is roped to a ring as described in the pole-axe method, and the operator, having released the safety-loop, rests the flat,

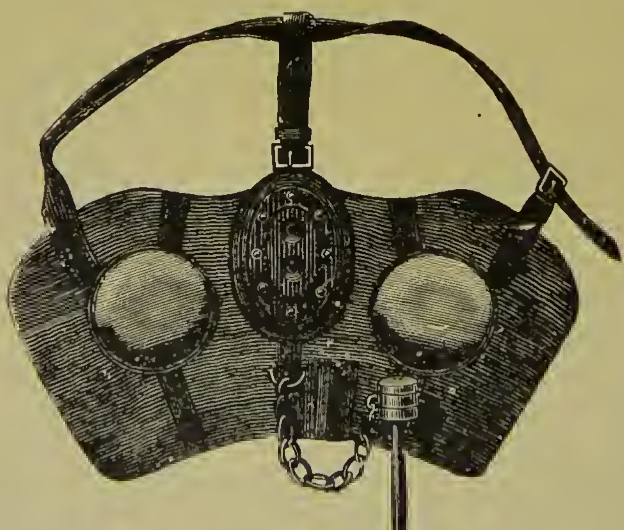


FIG. 18.—BRUNNEAU MASK, COVERING THE EYES, FOR HUMANE SLAUGHTERING OF CATTLE

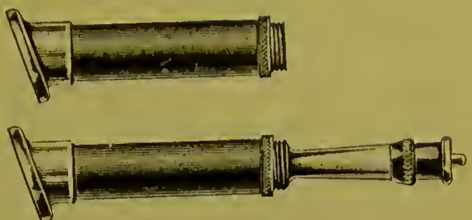


FIG. 19.—GREENER'S HUMANE CATTLE-KILLER

bell-shaped end on the animal's forehead. There is a "sight" on the bell which should point exactly upwards between the ears or horns. The projecting pin of the cartridge chamber is then gently, but smartly, hit with a small wooden mallet supplied, when the bullet penetrates right through the brain to the spinal cord and the animal falls instantly dead. If these instructions be carefully and accurately followed, the apparatus is perfectly simple to use and safe in its application. In large slaughterhouses on the Continent, it is customary to have all the shooting done by three or four men who are specially told off for this purpose and who do practically nothing else. As a result, these men become extremely expert in the use of the instrument, and the risk of any accident resulting from careless application or aim, or from any sudden movement of the animal which may cause the bullet to take a wrong direction, is reduced to a minimum. The size of the animal to be killed makes no difference to the success of this instrument, though, of course, it is not required in the case of very small animals. One great advantage of it is that bleeding can be performed immediately the animal falls to the ground, since the course that the bullet takes renders the operation of pithing unnecessary. By some this is said to induce bleeding to occur more freely and also to tend to improve the flavour of the meat as well as its quality of keeping. Greener's system of killing has now been extensively tried in Great Britain as well as abroad, and its use has been made compulsory by various councils as well as by the War Office and the Admiralty in their butchering and remount departments. In the case of cattle, which are easy to handle and very quiet, the system appears an entirely satisfactory one, as may be seen at such slaughterhouses as at Gothenburg, where this method of killing is entirely used.

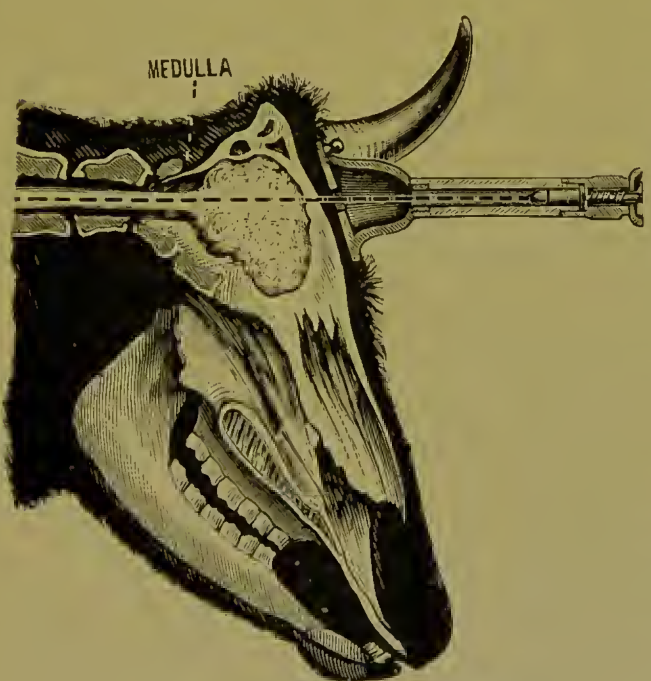


FIG. 20.—GREENER'S CATTLE-KILLER

This illustration clearly shows the position in which the killer should be placed. It is advisable to have the barrel in a line with the pith, but so long as the "medulla" is pierced, instantaneous death is assured.

Advantages of the Instrument. The manufacturers of this instrument claim that it possesses all the following advantages. As far as

FIG. 21.—SHEEP

The thinnest point of the sheep's skull, and therefore that on which the killer should be placed, is the centre of a line drawn across the head, about two inches above the eyes.

FIG. 22.—PIGS

Contrary to the instructions given for other animals, the bullet should never enter the head of a pig ABOVE THE EYES, but right between them. If the instrument is placed fairly between the eyes, or rather a shade lower, immediate death will result.

the actual killing is concerned, the bullet penetrates right through to the medulla, which is absolutely destroyed. There is no noise attending the discharge of the cartridge. There is no flash, and smokeless powder is used. The noiseless result is attained by means of the peculiar bell-shaped chamber at the end of the instrument, and the manufacturers claim that it cannot be attained by any other shooting instrument. Further, they maintain that the size and weight of this cattle-killer is such that it can be held in one hand by a person of quite poor physique, whereas some other shooting instruments are extremely heavy and require great physical strength for their use. Moreover, the instrument is of such a make that, although it is knocked about a good deal on the floor of the slaughterhouse, there is no damage done to it further than a little external denting, which does not in any way impair the safety and use of the apparatus.

It is particularly claimed that for a private house in the country, or at the kennels where old or injured or diseased animals have to be destroyed, the instrument is a perfect one. It causes absolutely a painless and instantaneous death, and even with regard to dogs can be most advantageously employed, because it does away with the somewhat serious danger of employing poison, which is apt to be attended with accidents. It is always to be remembered that the use of poison requires some skill in administration and some knowledge of the correct dose to be administered. In case of accidents to horses and other animals in the streets, it is claimed that this instrument would relieve much unnecessary suffering and abolish some distressing scenes if the police were permitted to use this killer and instructed how to do so. As it is, there is always considerable difficulty and time wasted in transferring such injured animals to the usual places where they are disposed of. It has also to be remembered that in the case of cattle there are various factors to be taken into account in estimating the efficiency of a method of slaughtering, such as, for example, the shape and the growth of the horns, the age of the animal, and the angle at which the blow from the pole-axe falls upon the head. It is claimed that the use of Greener's instrument obviates all these difficulties.

Mr. A. W. Holborn, Chief Veterinary Superintendent for the city of Manchester, in a speech delivered at a recent meeting of the Sanitary Congress, stated that he was most favourably impressed with the results attending the use of Greener's instrument and hoped that it would be

more generally employed. He went further than that, saying that he considered that, wherever stunning prior to bleeding was preferred, the use of such an instrument for bulls, rough-headed bullocks and such animals ought to be made compulsory by law.

Behr's Slaughtering Pistol. In this ingenious apparatus the great advantage is that no bullet is used nor cartridge, but the explosion drives a bolt out of the barrel with such force as to penetrate the skull of the animal in the usual position, thereby causing death. It is also so devised that the bolt is extracted automatically, returning into the barrel after the discharge. It is, therefore, precisely the same method as the ordinary pole-axe, except that the pistol is held in position over the forehead of the beast, which enables *an exactly accurate aim* to be taken.

The advantage of this instrument is obvious, namely, that having no bullet to be discharged there is no possible damage either to those using it or to those standing in the immediate neighbourhood. Moreover, only one hand is required to fire the pistol, the other being free to steady the animal's head if necessary or for any other purpose—a very convenient factor in the case of many small animals. The method of loading, or rather discharging, the pistol is shown in the illustration (Fig. 24).

DIRECTIONS FOR USE. *Charging.* After a slight pressure on the spring (*a*) the barrel of the weapon is to be turned towards the direction shown by the arrow " to open."

After having placed the cartridge into the chamber, the cartridge and the cartridge-expeller (*b*) (*see* dotted line of figure) is pressed into the chamber, and at the same time the barrel is turned in the direction shown by the arrow " to close " until the spring snaps in.

Discharging. The weapon must be held at right-angles to the animal's forehead, just over where the brain is situated, and then discharged. With the other unoccupied hand, the head of cattle, or other animals, can be fixed in the most convenient position.

The effect. The bolt is driven into the animal's brain and kills it instantaneously. The bolt then returns automatically into the barrel of the pistol, which gets separated from the animal before it has fallen.

Unloading. The bolt must be pushed back into the barrel by the handle of the screw-driver or otherwise against the cartridge-chamber. When this has been done, the pistol can be opened and loaded again. The empty cartridge is thrown out automatically from the cartridge-chamber by the ejector. Even when hundreds of shots have been fired off, no cleaning is required before finishing the daily work.

Cleaning, after finishing the daily work, is absolutely necessary.

Advantages of the Behr Humane Cattle Pistol. These may be stated as follows :

(1) After the shot the animal falls to the ground dead.

(2) All danger to people employed in the slaughterhouse is absolutely avoided.

(3) The discharging of the pistol takes place without any objectionable noise.

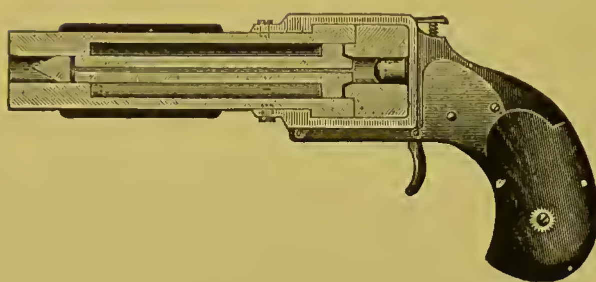


FIG. 23.—BEHR'S SLAUGHTERING PISTOL, SHOWING THE KILLING BOLT

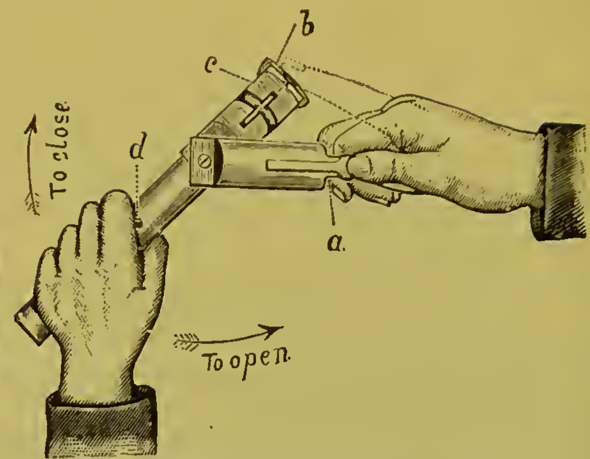


FIG. 24.—BEHR'S SLAUGHTERING PISTOL, OPEN FOR LOADING

(4) The cartridges are protected against dampness, which has to be reckoned with in slaughterhouses owing to the humidity of the surroundings.

(5) The bolt becomes free immediately after the shot, and returns into the barrel automatically.

(6) Only one hand is required for using the pistol, and this is of great

FIG. 25.—HUMANE SLAUGHTERING OF BULLOCK WITH BEHR PISTOL

importance in killing pigs, as the left hand is free for fixing the animal's head.

(7) The apparatus requires ordinary care, is quite free from danger, and its handling is most easy and convenient.

(8) The easy and rapid working of the pistol makes it capable of being used in slaughterhouses of any size.

(9) Whilst using the apparatus slight oiling is necessary in case the bolt gets dry, for which purpose the oil-box attached to the pistol has

Fig. 26.—The Cross represents the Point where the Extension on the R.S.P.C.A. Instrument is placed

to be turned round slightly, but not before the bolt is pushed back into the barrel.

(10) The apparatus never gets hot, even after hundreds of shots have been fired off in quick succession.

(11) There is no screwing of any kind connected with the use of the pistol, which might cause any trouble or delay.

(12) The apparatus may be cleaned rapidly and easily.

Sheep. The brain is situated far back in the skull of the sheep, and the skull-capsule is very hard.

When sheep or pigs are being slaughtered, the muzzle-piece should be put on the front of the pistol so as to prevent the bolt going too far in.

Cattle. The skull of a bullock is distinguished from other animals by the large development of the forehead. The bones are of considerable thickness and require a strong force to pierce them.

In Diagram No. 1 the position of the muzzle of the pistol is shown, and in No. 2 the direction in which the pistol should be held is illustrated.

Why are these Instruments not more used ? With all this evidence in favour of the use of some efficient shooting instrument the obvious

question arises, "What can it be which prevents the adoption of such an instrument universally?" Whatever may be urged in favour of these instruments by the makers and others, the plain, unvarnished fact remains that in nine slaughterhouses out of ten they are not used.

There must be some reason for this. We have endeavoured to the

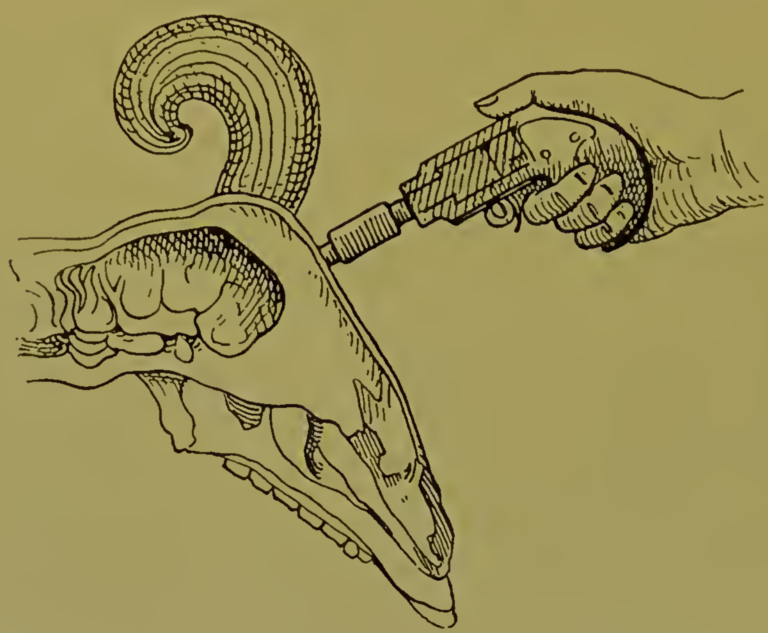


Fig. 27.—Position of Instrument when slaughtering a Sheep

utmost of our ability to ascertain from the practical men who have to deal with these matters what explanation can be offered for the fact just stated, viz., that the pole-axe still remains in this country the favourite instrument of slaughter. These inquiries have been made in various centres of Great Britain and from a large number of those interested in the trade. Frankly, the result is disappointing. We hold no brief for the advocacy of any one method of slaughter as against any other, provided always that the methods adopted have nothing to choose between

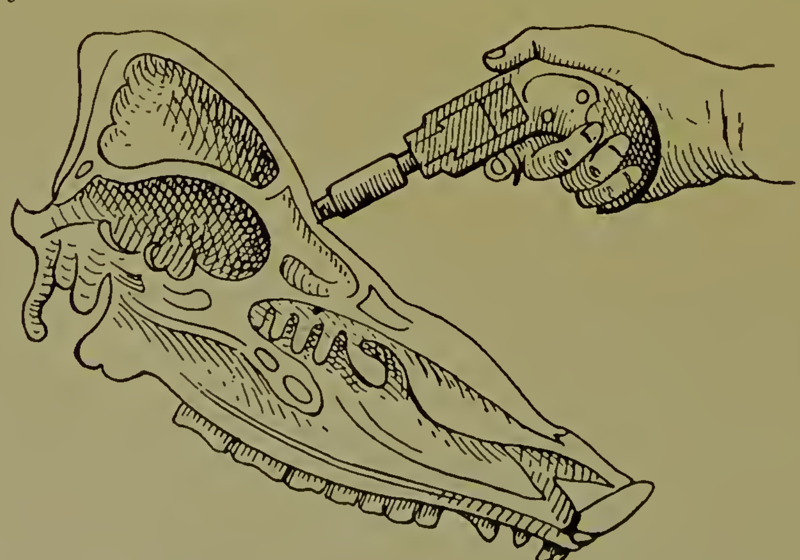


Fig. 28.—Position of Instrument when slaughtering a Pig

them on the grounds of humanitarianism and efficiency in results. We have been unable to satisfy ourselves that there is any objection which can be regarded as valid which is urged against the use of a shooting apparatus such as those described in this chapter. Again and again the question has been put to a practical man, " What is your objection to the use of a shooting apparatus ? " With disappointing monotony the answer has usually been, " We have used the pole-axe for such a long

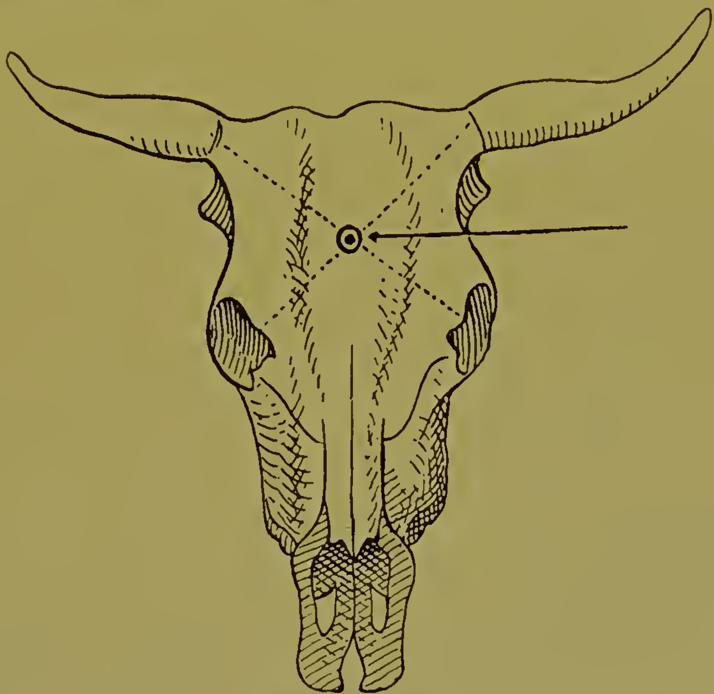


Diagram No. 1

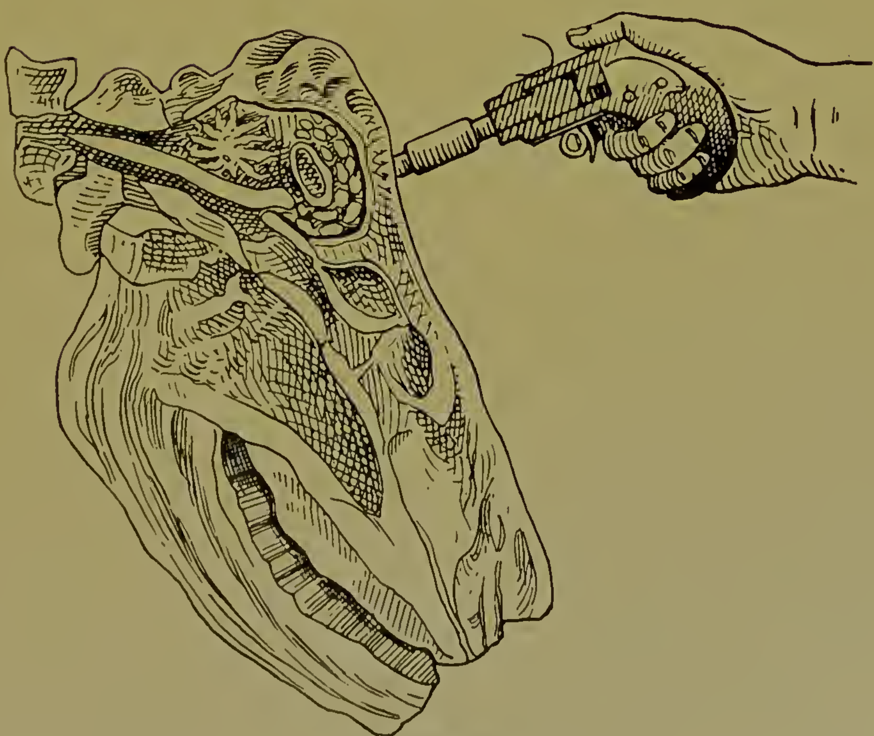


Diagram No. 2.

time and find it quite satisfactory, and we therefore do not care about introducing any change."

It is the same old answer which has reduced so many British occupations to their present hopeless competition with others. The plain truth of the matter is that in most of the industries in this country, of which this is only one, the attitude of those concerned is that what was good enough for our grandfathers is good enough for us, especially if we do not very obviously lose anything by maintaining it. Traced still further as to possible objections, some practical men have stated that these instruments are not used on account of their expense. Regarding the cost, a Greener's Humane Cattle-killer is 36*s.*; the cost of the R.S.P.C.A. Killer is 35*s.*; Behr's Pistol costs £4; and the instruments last for years. It is therefore perfectly obvious that the time saved in using such an apparatus would be paid for again and again by the owner. With every desire to place the matter impartially before our readers, we are forced to the conclusion that it is simply a question of the conservative attitude of mind characteristic of so many industries, and which resents the introduction of any improvements of any kind at all, which has kept these instruments from coming into general use.

For the illustrations of the use and application of these instruments, as well as of their construction, we are indebted to the courtesy of the inventor, W. W. Greener, of Birmingham, the secretary of the R.S.P.C.A., and Messrs. W. Douglas and Sons.

Koch's Pig-killing Apparatus. This simple device can readily be understood from the illustration (Fig. 31). It will be seen to consist of a bolt held in position at the end of a handle, the bolt being placed over the vulnerable spot on the forehead. This is then driven in with a hammer by a second operator and the bolt is afterwards released by the lever.

The Gothenburg Swine-killer. In the case of pigs the writer has not the slightest hesitation in giving his opinion that this apparatus is easily the best. Its object is rapid dealing with the animal. It is the invention of Mr. Sandeborg, the director of the slaughterhouse in Gothenburg, and is now being adopted in some of the German slaughterhouses. The apparatus, which is well shown in the accompanying figures (for the use of which we are indebted to the inventor), is as simple as it is extremely effective. It consists essentially of an oblong iron chamber into which the pig enters directly from the yard, through the wall. When the pig is driven in, it is followed up by an attendant, who closes the animal in the chamber by means of lifting the iron plate which forms the back of the chamber. At the other end, in the front wall, is an opening which corresponds to the size of the head of the largest pig, and this is placed at such a height from the ground that, when the pig is driven in, it pushes its head through this opening, there being no room for it to do anything else. As the back iron door is closed, the pig is pushed right forward into this position. To all intents and purposes, therefore, the apparatus consists of a closed stall for the pig, from which the head protrudes in front. The actual method of killing is no part of the invention, which

Fig. 29.—Humane Slaughtering of Sheep with Behr Pistol

Fig. 30.—Humane Slaughtering of Pig with Behr Pistol

consists essentially in placing the pig in position so that there is no struggling. In the Gothenburg slaughterhouse we have seen pigs killed in this machine either by a hammer, a bolt, or, in the case of very large animals, by the shooting apparatus which is there used for the cattle. Immediately the blow or shot is delivered, one side of the chamber falls out or is raised, upon which the pig immediately, of course, also falls out on its side and is bled without a moment's loss of time. The situation of this machine in the abattoir is so arranged that the carcase is in immediate contact with the apparatus required for the next stage in the process, being readily transferred to the scalding apparatus.

By means of Sandeborg's machine it is quite easy to slaughter thirteen pigs in six minutes, this saving of time being chiefly effected because of the absence of any possibility of struggling on the part of the animal. We have no hesitation whatever in recommending the use of this apparatus in any establishment where the rapid and convenient slaughter of pigs is desired. A careful examination of the figures reproduced here will make the understanding of this machine perfectly simple.

The English Patent Method of Killing. This method, although it is termed the English method, has probably never been seen or used in this country by the majority of present-day butchers. So much so is this the case that the present writer first heard of it on the Continent. It was originated some eighty years ago by a Dr. Carsan, and the essential point about it was the puncturing of the chest-wall between the fourth and fifth ribs. This was done while the animal was either standing or thrown. Immediately after the puncture was made, air was forced into the chest through a pair of bellows, and the animal was thereby suffocated.

It was peculiar for the reason that the operation of bleeding was omitted, and meat which was prepared from carcases slaughtered in this manner, in which therefore all the blood was retained, was known as "patent meat." Those who advocated it claimed that the meat was rendered more nutritious and more tender, and also, it was stated, that

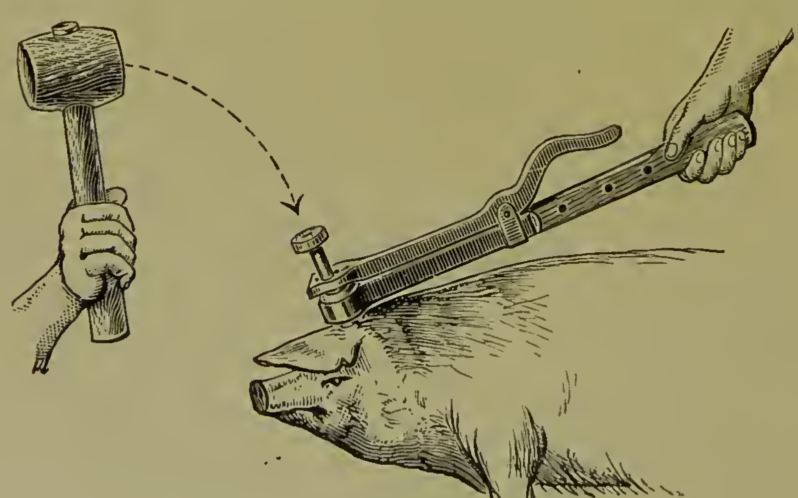


Fig. 31.—Koch's Pig-killing Apparatus

FIG. 32

FIG. 33

SANDEBORG'S PIG-KILLING APPARATUS

The first illustration gives a side view, while in the second the act of killing, with the pig in position, is seen.

the carcase set more quickly. At the best it must be considered a cruel method of slaughter, and need not be described further.

Neck-stabbing. This is another method of slaughter which is not seen commonly in this country, though it is largely used in Africa, India, and Australia. It consists essentially in dividing the spinal cord with a long sharp-pointed knife, which is thrust into the neck of the animal between the first vertebra and occiput. This procedure immediately renders the animal paralysed but does not immediately destroy consciousness. The operation of bleeding is performed immediately the animal falls (*see* Vol. II.).

Throat-cutting or Transfixion. A large number of small animals are slaughtered simply by having their throats cut without any previous stunning or other preliminary proceedings. Thus sheep, calves, and pigs are frequently killed in this manner. The exact point at which the knife is introduced varies in the case of each animal, but in each case the object is the same, namely, the severance of the principal blood-vessels in the neck, after which the slaughterer bends the head right back until the neck is broken. Occasionally both calves and pigs are suspended by their hind legs before bleeding, and stunning may be performed prior to the severance of the blood-vessels. None of these methods is so satisfactory as those already mentioned.

Jewish Method of Slaughter. Lastly, we have to consider the method of slaughtering adopted by the Jews, who still retain this special system in spite of the obvious cruelty involved. The essential feature of the

Jewish method of slaughter, which is at the same time its chief objection, is that there is no preliminary stunning of the animal by any procedure, and therefore the animal is fully conscious. The regulations for the carrying out of this method are not found in biblical literature but are a command of the Tomad, by direction of a number of Rabbis. Inasmuch as the animal is not stunned, it becomes necessary to render it incapable of active struggling and so interfering with the slaughter, and therefore complicated arrangements for throwing the cattle have been devised and recommended. Whichever be adopted, the result is that the animal is thrown upon its side and the head secured so as to prevent it knocking against the floor and struggling. The legs are extended and secure. Ostertag says that all the complicated apparatus for throwing cattle to be slaughtered by the Jewish method are entirely unnecessary, and that the simplest, safest, and surest method consists in the so-called casting, for the practice of which nothing but a rope of about sixty feet long is required. This method was first of all devised by a German veterinarian for surgical practice, but was first ordered to be used for slaughtering in the Jewish method by the Russian authorities, to whom it was suggested by societies for the prevention of cruelty to animals. The rod is fastened to a ring, and thence passed round the horns of the animal, then round the body just behind the fore legs, with a slip-knot on the back, and then a second time round the body just in front of the hind legs, with another slip-knot on the back. When applied in this way and pulled upon tightly, the animal slowly rolls over on its side. In another method the animal is secured to a ring in the floor by a chain round the neck, and the fore feet are then shackled with a short chain. Another chain some thirteen feet long, which has a hook at the end of it, is fixed to one of the animal's hind feet, after which it is wound round the chain on the fore feet of the same side of the animal. The long chain is then pulled up and hooked in the middle of the bullock-tree, which is then slowly wound up, causing the animal, thus supported at its head and tail, to roll slowly on its side.

Jakob's Apparatus. However the animal be thrown and secured, the actual method of killing is by making one swift, wide, sweeping cut across the neck, which severs the jugular vein. It can easily be understood that unless the head of the animal is very securely fastened it is apt to work loose as soon as the cutting of the throat is begun, and to struggle violently. In order to prevent this, an apparatus was devised by Jakob, consisting or an iron rod about five feet long forked at one end, the ends of the prongs being bent in the shape of hooks. The other end is a handle. Attached to the iron rod is an iron ring, which can be moved along the rod and fixed by a screw. The use of this apparatus is to grasp the horns of the animal by the hooked ends of the prongs. By this means the animal's head is firmly secured. Various modifications of this apparatus have been devised.

According to Jewish regulations the slaughterer can only be a person specially trained in medical and surgical science, especially in anatomy

and he is to pass an examination on this subject before he is allowed to act in this capacity. Not only so, but he must be able to detect any blemishes of whatever nature in the carcase, which must according to their rules be absolutely perfect in order to be partaken of as food. Meat so prepared is termed " kosher " meat.

No carcase having traces of any kind of disease or other lesion which could have caused suffering to the animal before death is allowed to be passed for food. In some cases only the fore-quarters are eaten, and in all cases every trace of blood has to be removed from the flesh before it is passed. The meat must not be kept longer than three days after being cut up. It is then soaked in water and sprinkled with salt and allowed to remain for half an hour, all these precautions being devised in order to remove the slightest trace of blood.

Advantages claimed for Jewish Method. The advantages claimed for the Jewish method, or " schecheta " as it is called, are that in this way the carcase is bled more perfectly than under any system in which the animal is stunned before having its throat cut. In answer to the objection so often raised against it of cruelty, the advocates of the Jewish method reply that sheep, calves, and sometimes pigs are also killed on the same system. The answer is no answer at all—it does not make the method less cruel because it is practised on other animals. Moreover, the large size of the animals dealt with by the Jewish method renders them more likely to be imperfectly slaughtered and to injure themselves in struggling. The Jewish operator uses a knife of exceeding sharpness and is thoroughly skilled in his work, so that loss of consciousness rapidly follows from general anæmia of the brain. It has also been claimed for this system that *rigor mortis* sets in more rapidly on account of the rapid exit of the blood. It is doubtful whether there is any advantage gained as far as the setting and keeping quality of the carcase is concerned, and the unquestioned cruelty of the whole system is a sufficient condemnation, or ought to be, in any civilised community. The time has surely gone by when any ethical value should be attached to a method of slaughtering, except on the grounds of humanitarianism.

Consideration of Methods of Slaughter. From what has been already said in the preceding pages it will be quite obvious that there are several distinct questions involved in the consideration of which method of slaughter should be recommended, if, indeed, there be any one method which can be regarded as superior in every respect to all the others. Thus we have to consider not only which method secures the death of the animal most rapidly and humanely, but also which method is of the greatest benefit to both the butcher, purveyor, and the consumer from the point of view of the keeping qualities of the meat and its capacity for nourishment. There is thus both a practical and what may be termed a sentimental side to the question of slaughtering.

The discussion, as far as the humanitarian aspect is concerned, has already been dealt with, but we would add a further word or two in connection with the other aspect of the question, the practical side,

particularly in connection with the Report issued by the deputation appointed by the Belfast City Council in 1909, who were instructed to visit certain abattoirs in England and on the Continent and report their conclusions. The deputation found in the continental slaughterhouses that either the stunning method or the shooting method was generally adopted. Thus in Rotterdam and Hamburg the pole-axe is the instrument used ; in Berlin the sledge ; whilst in Cologne (and, as we have said elsewhere, in Gothenburg) the shooting apparatus is the system adopted. Each of these methods has its own disciples, and with a view of making a practical experiment in the direction of testing the relative advantages and disadvantages, the following experiment was carried out in Belfast when the deputation returned home.

The Belfast Experiment. This experiment was directed particularly towards deciding upon the exact posture of the animal at the moment of its death, the nature of the bleeding afterwards, the colour of the flesh resulting, and the keeping properties of the carcase. For the purposes of the experiment three series of animals were taken, consisting of two animals in each series, one killed by the stunning method and the other by the shooting method. The report sums up the results of all three experiments, all of which agreed in their conclusions, in the following tabulated statement which is quoted from it :

STUNNED ANIMAL.	SHOT ANIMAL.
Fell immediately with limbs relaxed.	Fell immediately with limbs strongly flexed.
Bled well.	Bled less rapidly.
Flesh paler than that of "shot" animal.	Flesh, bright red.
On microscopic examination blood-vessels emptied.	On microscopic examination blood-vessels gorged with blood.
Flesh kept well.	Flesh showed signs of putrefaction twelve to fifteen hours before that of stunned animal.

Microscopic Examination. Perhaps the most interesting statement in the above table is that which refers to the condition of the blood-vessels regarding the contents of blood as seen when examined under the microscope. It will be seen that in the case of the stunned animal which was subsequently bled the minute blood-vessels were found to be perfectly

emptied of blood, whereas, on the other hand, in the case of the animal which was shot and subsequently bled the minute vessels were found to be engorged with blood. This, of course, corresponds with the other statements made in the table, namely, that in the case of the stunned animal the flesh was found to be paler in colour than that of the shot animal, in which it is described as bright red. We give the results of this experiment exactly as described in the Belfast Report, and would only add that the question here raised in connection with the bleeding from the minute vessels appears to us to be one of very considerable importance, and one which should be thoroughly tested in different species of food animals by means of a still more exhausting investigation. For, be it noted, the results stated, particularly in connection with the keeping qualities of the carcase, are by no means uniformly agreed to by many men of great practical experience in the meat trade. The point is an extremely interesting one and, as we say, deserves fuller investigation.

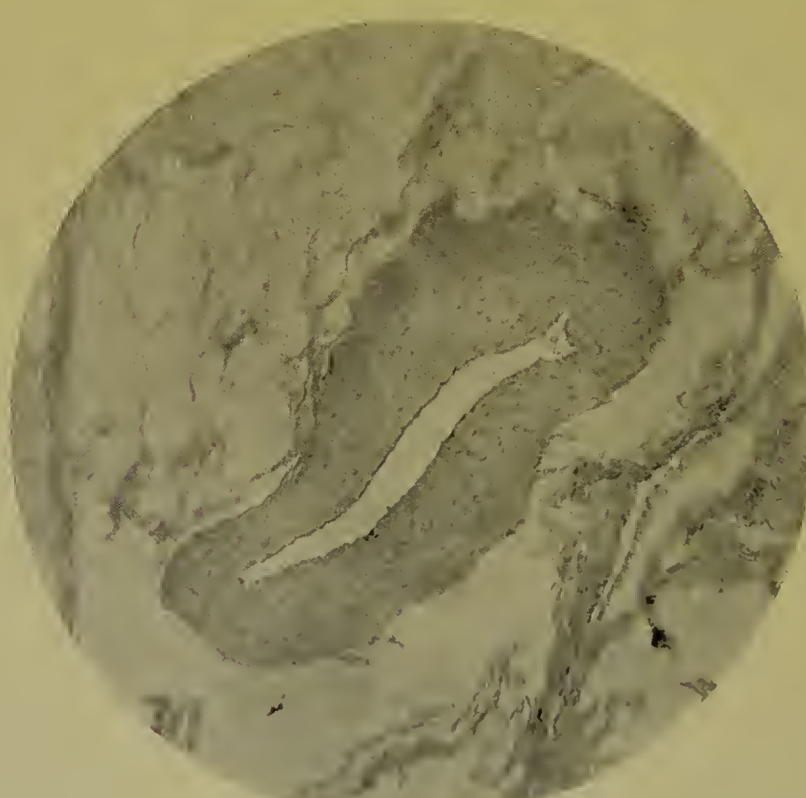
Keeping Qualities of the Carcase. Another very striking conclusion is arrived at in the Belfast experiment, and one which is a severe condemnation from one point of view of the shooting method of slaughtering if it be found to be of uniform occurrence. We refer to the statement that while in the case of the stunned animal the flesh kept well, in the animal which was shot, on the other hand, the flesh showed signs of putrefaction twelve to fifteen hours before that of the stunned animal. The importance of such a statement can hardly be over-estimated when judging the value of the relative methods of slaughter, for this is one of the aspects of the question which deserves the very greatest weight in coming to a conclusion. The statement seems to us to be bound up with the preceding one, namely, that in the shot animal the vessels were found full of blood. If that be true, then, it is another way of saying that the animal which is *shot* and then bled still retains within it an immensely greater quantity of fluid than does the animal which is *stunned* and then bled. Now the fluids within the bodies of animals which have been killed are the factors which determine chiefly the rapidity of the onset of putrefaction and the degree to which that process can readily attain. All organisms require a certain amount of moisture in order that they may flourish, and the putrefactive germs are no exception to the rule. Moreover, the fluid contained in the blood-vessels in a carcase after death is precisely that which favours the occurrence of this degenerative change.

As we say, these two statements hang together in determining the value of this experiment on the two methods. Given the fact that the carcase by the one method is much more moist afterwards, from the contents of its minute vessels, than in the other case, it could be prophesied without difficulty that it would decompose with greater rapidity, other conditions being equal.

The first statement in the tabulated report above may also possibly have some bearing upon this question. It will be noted that the experimenters report that the stunned animal fell immediately with its limbs *relaxed*, whilst the animal which was shot, though, of course, falling

SECTION OF DIAPHRAGM

Showing blood-vessel gorged with blood. Animal killed by shooting with Greener's apparatus.



SECTION OF DIAPHRAGM

Showing contracted and empty blood-vessel. Animal killed by stunning with sledge. The Belfast Experiment.

immediately dead, did so with the limbs strongly *flexed*. This would seem to indicate that the shock to the nervous system is much greater in its effect in the case of shooting than in the case of stunning, the effect being measured by the violence of the contraction of the limbs as mentioned. Whether this is the real explanation or not, as has been suggested, we are not prepared to say, but the practical conclusion from this experiment, taken as it stands by itself, is an extremely important one.

Practical Conclusion. It must be conceded that the practical conclusion of the Belfast experiment, if it be confirmed on a larger scale, is that in the case of shooting the animals do not bleed so well as in the case of stunning ; and further, those carcases which were those of animals which had been shot showed signs of putrefaction a very considerable time sooner than those which were stunned.

Comment on this Experiment. While the results of the Belfast experiment, so far as they go, are extremely interesting and of importance, we feel bound to add that in our opinion the experimenting was not conducted on a sufficiently extensive scale to warrant any general conclusion on this very important question. In order to arrive at such a conclusion it would be well to slaughter, not two or three, but two or three hundred animals of the various food species by the two methods, under exactly the same conditions of season and temperature and so forth, and carefully observe the results, especially as regards the commencement of putrefaction. We do not say that the conclusion would be different, but that it would be a safer one ; and, in any case, there is a still further point to be noted which militates very considerably against the supposed disadvantage of the shooting method. That point is this. It is not stated *what the exact period was* which elapsed before putrefaction showed signs of commencing in the animals which were shot. Any carcase will putrefy if it be kept long enough, no matter by what means the animal met its death, and if the putrefaction only sets in after such a time has elapsed as will be more than sufficient in the ordinary course of events for the meat-purveyor to have sold the meat and the consumer to have consumed it, then the advantage of the method is null and void. Moreover, in any case if there were a proper system adopted in this country, as is the case on the Continent, whereby all carcases are transferred to the chill-room after slaughter and there retained until the meat-purveyor requires them for purposes of sale, there would be no disadvantage in the method of shooting. Indeed, as the report itself concedes, the meat would be all the more tender and nutritious from the very fact of its containing a greater percentage of fluid. It follows, therefore, that many considerations have to be taken into account in coming to a conclusion on this subject. We have no desire whatever to dogmatise on this matter, but only to place as far as we can all the facts which bear upon the various sides of the question fully and impartially before the reader.

We would further add that the blood-vessels selected for microscopic examination, namely, those in the diaphragm, are not the best adapted

for the end in view, because they are affected as regards this very point by the process of respiration. Moreover, we feel that the number of animals experimented upon is hardly sufficient to warrant the drawing of very definite conclusions, and in view of the great importance of the question at stake, we would suggest that a far more extensive experiment be carried out upon similar lines, taking care that all the conditions of each series of slaughterings are as nearly identical as possible. The Belfast experiment, for particulars of which we are indebted to Dr. Trimble, is an intensely interesting one, and should be followed up.

Conclusion regarding Slaughtering Methods. The plain truth of the whole matter is that at the present moment the data upon which to form a dogmatic opinion as to the best method of slaughtering for all purposes are not available. One would need to know, in the very first place, *exactly what structures in the brain and medulla* are destroyed in each method, and so far as we are aware that exact knowledge is not forthcoming. When it is, and not until then, the physiologist will be able to tell us without difficulty what will be the effect upon the condition of the blood-vessels, &c., in any given method.

Blowing up Carcases. The custom of producing what is known as "blown veal" and "blown lamb" by means of inflation has been for years pretty general in various parts of the country, more common in some than in others. It is carried out sometimes by the mouth of the slaughterer and sometimes by means of an apparatus known as a calf-blower.

Dr. Hope, M.O.H. of Liverpool, thus emphatically states his view of this practice : "In many towns this practice still exists among the lower-class butchers of blowing up with the breath the connective tissue of veal and lamb, and thereby giving an appearance of plumpness to poor meat ; this disgusting fraud is completed by taking melted fat into the mouth and blowing it over the freshly dressed carcase. The practice is an offence against ordinary by-laws, and may be recognised by the emphysematous condition of meat which has been subjected to it."

The method of procedure in the case of calves is to make a puncture in the skin and forcibly drive in the air, which has the effect of making it more easy to strip the hide off the carcase. By thoroughly hammering the carcase with the fist the air is distributed throughout the subcutaneous tissues. Inquiry amongst a certain class of traders illicits the information that they live under the delusion that meat so treated will keep better than it otherwise would do.

It is needless to say that the mere forcible injection of air in this way can confer no keeping qualities upon the meat, while, on the other hand, it may readily introduce impurities, bacterial and otherwise, which may have an entirely contrary effect. As far as the practice of blowing from the mouth is concerned, it can only be characterised as absolutely disgusting, in addition to being utterly unnecessary. Even where there is a special instrument for the purpose, it is not easy to see how it can be applied in such a way as to secure that any impurities in the air are not injected along with it.

MEAT INSPECTION IN HOLLAND

A SERIES OF ILLUSTRATIONS SHOWING THE EXACT METHODS OF INSPECTING PIGS AND CALVES

Pig Inspection: Opening the Killed Animal in Presence of Inspector

External Inspection of Carcase

INTERNAL INSPECTION OF CARCASE

As a Result of the Inspection of the Carcase the Inspector cuts open a Gland found to be swollen

Inspection of the Inguinal Gland

Inspection of the Sub-maxillary Gland

INSPECTION OF THE LUNGS, &c.
The inspector is cutting open the bronchial gland.

INSPECTION OF THE LUNGS OF CALVES, HOLLAND
The inspector is cutting open the bronchial gland.

Inspection of the Intestines of Calves, Holland
The inspector is cutting open the mesenteric glands.

INSPECTION OF THE INTESTINES WITH GLANDS
The inspector is cutting open the mesenteric glands.

Inspection of the Liver

LABELLING THE CARCASE

THE LABELLED CARCASE

A Series of Labelled Pork Carcases

CHAPTER II

METHODS OF INSPECTION

Lack of Method in Britain. It is a simple and curious fact that Great Britain, which has been regarded as the cradle of scientific hygiene, should be lamentably behind other European countries, as well as America, in the methods adopted for the proper inspection of meat. It is an example of the lack of uniformity, characteristic of our nation, in the way in which we apply our scientific knowledge to important commercial undertakings. It is not too much to say that the subject of meat inspection is one of tremendous importance to the public, from the personal, municipal, national, and international standpoints; and it is possibly just because it is one of those questions which is everybody's business that up to the present it has been so largely nobody's business. One has only to compare the literature of our own country on this subject with that of Germany, for instance, to realise how extremely difficult it has been for our British meat inspectors, in the absence of a special training in foreign languages, to do full justice to the material which came under their observation, and hence we have had to rely largely upon continental text-books and journals for most of our systematic information. The day is coming, however, and is indeed very near at hand, when the whole subject will be in a very different position in this country. The time cannot be far off when the whole industry, as far as slaughterhouses and abattoirs are concerned, will be placed by law under one universal definite recognised system, established by government and administered by the local authorities. The sooner that time comes the better for all concerned, and until it does come there will be no security for proper protection to the public. As it is, there is no system of meat inspection which may be called British. Every centre has its own method, or in many cases no method; in fact, it is the astonishing truth that there are some quite large centres of slaughtering in which there is not a single qualified meat inspector employed to supervise and safeguard the public interests. It ought to be continually pressed home on the authorities that *every animal which is slaughtered for human food, before being exposed for sale, should be inspected by a thoroughly trained and qualified inspector,* upon whose shoulders the responsibility for withholding from human consumption unfit food should rest.

What Safeguards the Public? It may be asked that if this be true, namely, that meat inspection in this country is so hopelessly insufficient, how is it that the public do not suffer more than they do from the consumption of meat which ought to be condemned? The answer is to be

found in the present state of the British law upon the matter. In this country we do not take anything like ample precautions to prevent unfit food being placed upon the market, and in many districts take actually no precautions at all. What we do is to punish very severely any meat-purveyor *who is found out* in the act of selling food which is unfit for human consumption. In other words, the law places the responsibility upon the vendor, and thereby indirectly prevents any attempt to dispose of inferior food in the poorer quarters of our cities and towns, where cheapness is the main consideration in the purchase of food. The administration of this law varies greatly in many districts as to its severity; and it is quite true that where it is rigorously carried out, and heavy penalties imposed upon those who are detected, the public are fairly well protected. But dealers in meat know perfectly well where they can dispose of meat with comparative safety and freedom from inspection, and those who are behind the scenes in this matter can tell you exactly in which markets in the country you will find carcases which would be seized and condemned in some other places. The plain truth is, of course, that the number of qualified meat inspectors in Great Britain is hopelessly inadequate to supervise the industry efficiently. In the future, when the ideal system of meat inspection has been adopted, there will be a demand for a great number of thoroughly qualified and well-trained veterinary meat inspectors; but until that time arrives the only way is to do as is done at present, namely, to place the responsibility upon the vendor. It should be remembered, however, that the meat-seller in certain localities is not by any means necessarily acquainted with all the conditions which render his meat unfit for human consumption.

Expense of Inspection. If it be objected that the expense of carrying out meat inspection on the scale and system above indicated would be too great, the answer is that no expense is too great in a matter of such universal importance. The health of the community in general and its protection from disease is a national asset whose value cannot be calculated, and no money spent to secure that end can be considered as an unwarranted expense. Moreover, it would not be at all difficult so to arrange that an efficient inspection should take place of every carcase slaughtered throughout the country. What is done in such comparatively poor countries as Denmark can surely be accomplished by a wealthy State like Great Britain. All that is necessary would be to appoint a veterinary surgeon in any country district in the absence of special meat inspectors for the locality—to be the Government inspector for that district. All animals slaughtered within a given radius should be visited by him on set days, and these functions could be very well made to fit in with the general practice of the country veterinary surgeon without adding any great burden to the financial liabilities of the district. It is only what has already been done in the case of public vaccinators, where every medical practitioner is regarded as a Government official as far as vaccination is concerned. It is, of course, a necessary sequence

of such a system that the subject of meat inspection shall receive adequate attention at our veterinary colleges, and, as a matter of fact, it does so at the present moment in some of them.

Abattoir Inspection. Even in those large slaughterhouses where to-day there are qualified meat inspectors appointed, the system cannot be regarded as anything like efficient, chiefly for the reason that there are far too few inspectors to get through the work. There is no use blinking the fact that in this nation at any rate, and probably in most others, the standard of commercial morality is not so high as to prevent unscrupulous persons endeavouring to evade the law and to dispose of their merchandise upon an unsuspecting purchaser. There are, of course, great numbers of meat-purveyors who are absolutely above any such proceedings, and whose great aim it is to conduct their business on the best possible lines, but, on the other hand, in the meat industry, as in all other industries, there are those who are quite willing to deal in an inferior class of goods, if they can dispose of them at a profit. These men are up to all the tricks of their trade, and know exactly what to do to a carcase affected with certain conditions in order to conceal from any ordinary hasty examination the evidence of disease. It is not a difficult matter to remove traces of lymph if it be recent, slight tuberculosis deposits which are local, tumours which can be excised and parasites which may affect portions of organs, and so forth ; and unscrupulous dealers have no hesitation in resorting to these methods. In a large slaughterhouse, with perhaps thirty to fifty slaughtering-booths in it, and only three or four inspectors to supervise the whole work (and even that number is by no means always found in Great Britain to-day), it is quite impossible for any adequate inspection of the carcases to take place as they are slaughtered. The fault is very often primarily in the structural arrangements in the slaughterhouse itself, these being such that *no general view can be obtained* by the inspector of what is going on, he being compelled to visit each booth separately in order to make his examination. It is no exaggeration to say that the great majority of animals are killed and opened in the absence of the inspector, and no precautions are taken, or at any rate not systematically, to enable him to identify *any organs* which may subsequently attract his attention *with the carcase from which they came.* It is a comparatively easy matter to destroy diseased organs, or at any rate to remove them from view and to substitute healthy ones. The severe penalties imposed upon the vendor of diseased meat are the only safeguard, and it therefore happens that the slaughterers themselves more frequently draw the attention of the inspector to any abnormal carcase than does he find it out for himself —at least this is quite a common occurrence. We repeat, this is not a matter of blame for the inspectors, it is a simple question of being unable to be in more places than one at the same time.

Present Defects in our System. The slaughterhouses are understaffed ; the number of qualified meat inspectors in the country is absurdly inadequate ; the trade is an immense one, and the public are ignorant

and apathetic. It will never be satisfactory until the responsibility is reversed and the burden removed from the meat-purveyor, who may be ignorant of disease, to the shoulders of the meat inspector who is thoroughly qualified ; and that can only be **done by making provision for a full, adequate, and careful inspection of every single animal slaughtered or imported ; every such carcase being duly stamped after examination with a mark which can be interpreted by all who have to deal with it, and which signifies the decision of the meat inspector concerning it.** Only in this way can the public secure any guarantee that the meat which they buy in shops has been duly inspected and warranted free from disease. Of course there are difficulties in the establishment of such a system, as there are in organising any great system, but difficulties exist only to be overcome, and in this particular case they are by no means insuperable.

An Ideal System of Inspection. Before passing on to describe the duties of the inspector, as at present laid down for him, and the conditions which he may expect to encounter in his work, let us briefly sketch what we should consider an ideal system of inspection, such as a scientifically trained veterinary inspector would desire to introduce were he in the position to do as he wishes ; and supposing that he were placed in charge of a municipal slaughterhouse and requested to organise the system of inspection upon modern scientific lines. Such systems are already in everyday use in various continental countries. We have only to take the best in each. They may be seen and studied in Germany, Denmark, and Sweden and in many other places, and it is well worth the while of any meat inspector who wishes to be thoroughly imbued with the details of a perfect system to spend a few weeks in one of the well-known abattoirs, observing carefully all that is done.

Site and Construction of an Abattoir. In the first place, the advice of the scientific meat inspector should be sought before the slaughterhouse is constructed, in order that it may be arranged in such a way that a proper system of inspection can be efficiently carried out. This is one of the great difficulties in a country like our own, where existing arrangements are of considerable antiquity and involve very many financial interests which frequently are not identical. For example, the first essential is that the slaughterhouse should be so situated that when the animals arrive they can be deposited (by rail or canal) at the gates of the market, without being taken through the streets of the city, into which indeed they never ought to enter until dressed for sale. These and other matters connected with the arrangements of slaughterhouses have already been fully dealt with and need not be further considered here (*see* chaps. ii. and iii., Vol. II.). We will assume that the slaughterhouse has been built with due regard to all the considerations laid down, and that notice has been given that a certain number of animals will arrive at the slaughterhouse or the market, both of which should be in communication with each other, and at a definite time and on a definite day. This notice is essential in order that the

INSPECTION OF INTESTINES

Shown lying on the floor, the common but uncleanly method. The abattoir itself is well arranged.

INSPECTING ORGANS ON A TABLE (AMERICAN)

markets, yards, pens, and so forth shall be ready for their accommodation on arrival.

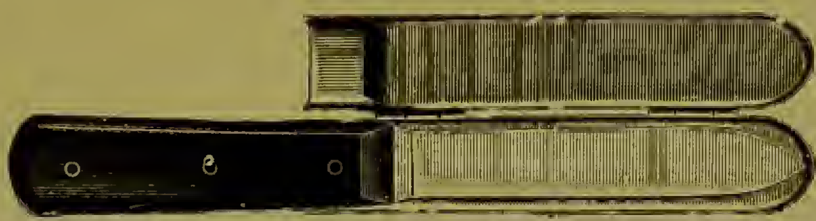
Preliminary Inspection. On arrival of the consignment of animals they are met by the inspector or inspectors and unloaded in his presence. They should be first of all passed into yards or pens immediately adjoining the railway platform, or canal siding, as the case may be, where a superficial examination of the exterior of the animals can rapidly be made. Here the inspector observes any cases of injury which may have occurred during transport, or any obvious cases of infectious disease amongst the animals, and deals with them accordingly, isolating the infectious cases at once from the others which are healthy. The subsequent procedure will depend upon whether the animals have been already sold and consigned to butchers for slaughter or whether they have still to be offered for sale in the markets. In either case the inspector has no more to do with them until they have passed through the market yards if still to be sold, or have otherwise actually reached the slaughterhouse premises.

Time of Slaughtering. Slaughtering should always be limited to certain hours of the day in order that the inspectors may always be on duty at the times when it is going on, and in order also that the slaughtering itself and the inspection can take place in an adequate light. Those hours will depend upon local circumstances, and will vary according to the time of the year and the facilities offered by the individual slaughterhouse.

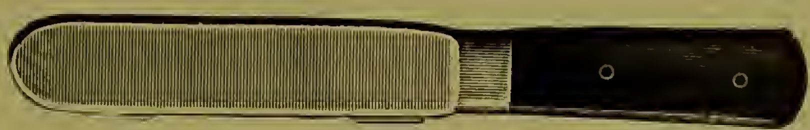
Killing in Presence of Inspector. Arrived at the slaughterhouse, the animals are killed by one or other of the methods already described, but in any case *in the presence of the inspector.* The animal having been bled and, in the case of cattle, for example, the preliminary portion of the skinning process having been carried out and the feet removed, the carcase should then be hauled up *off the ground* by one or other of the various overhead mechanical contrivances devised for this purpose, and the further skinning carried out then. This is a very important point which is omitted in many places in Great Britain. It is quite common to skin the carcase entirely while it lies on the floor, and even to disembowel it in that situation. In this way the meat comes in contact with anything that may be upon the floor, which is itself, as a rule, disgustingly dirty, whereas it ought to be scrupulously clean ; and as often as not the organs are thrown on one side in a heap, rendering it impossible to identify them. The carcase should then be hung up at once at such a height from the floor that a large metal tray in the form of a hand-cart can be wheeled underneath it, before the abdomen is opened. This hand-cart is for the reception of the contents of the abdominal cavity—the stomach, the intestines, the spleen, &c. When the incision is made and the organs allowed to fall out in front, the inspector facing them, he can at once observe whether they are in a general state of health or otherwise, and certain diseases can immediately be recognised. When the organs are separated and lying in the hand-cart, this should be

TYPICAL EXAMPLES OF KNIVES USED IN MEAT INSPECTION

MEAT INSPECTOR'S POCKET KNIFE

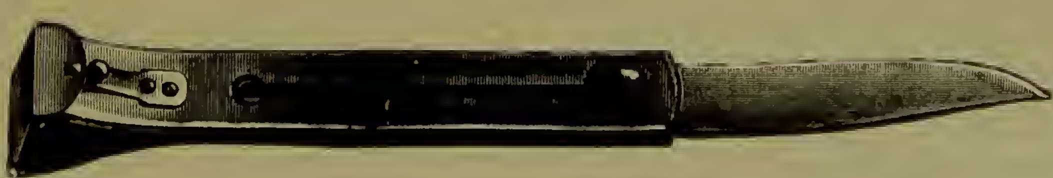


MEAT INSPECTOR'S KNIFE WITH ASEPTIC NICKEL SHEATH



MEAT INSPECTOR'S KNIFE IN ASEPTIC NICKEL SHEATH

MEAT INSPECTOR'S KNIFE (BERLIN)



KOCH'S ASEPTIC KNIFE

TAIL OF AN OX WITH NUMEROUS NODULES HAVING THE STRUCTURE OF "FIBRO-SARCOMATA," CONNECTED WITH THE MUSCLES OF THE TAIL AND THEIR TENDONS

Was sent as a possible case of tuberculosis, but there was not the slightest evidence of tuberculosis obtainable. Rare. (Preparation by S. Delépine.)

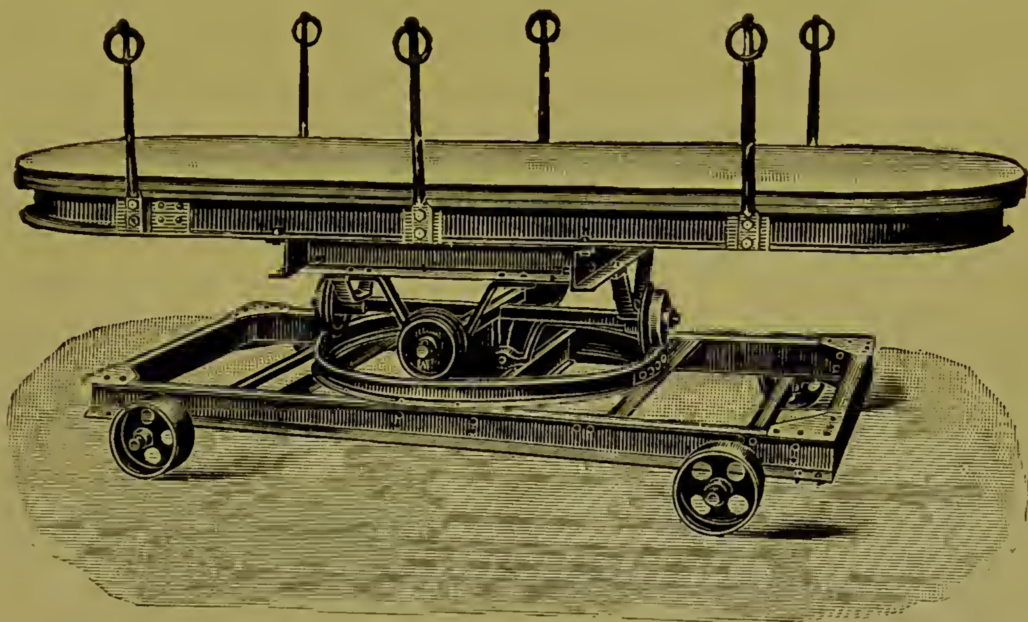
wheeled a yard or two on one side to allow the slaughterers to proceed with the further dressing of the carcase.

Inspection of Abdominal Contents. An assistant then quickly spreads out the folds of the intestines (*see* p. 779), and the inspector, with a rapid circular sweep of his knife, cuts longitudinally through the mesenteric glands, exposing their interior, with a view to observing the presence or absence of tuberculosis especially, but also to see the general condition of the glands. The exact attitude and method of procedure here described is seen illustrated on pages 779 and 780. The inspector then rapidly examines the spleen, stomach, and the intestines themselves, and should he find them all perfectly healthy stamps them with a pocket-stamp devised for the purpose (*see* Fig. p. 797), indicating that they are perfectly free from disease. The contents of the tray, or hand-cart, are then wheeled by an assistant to that portion of the building where they are further treated, according to their ultimate destination in the preparation of tripe or other purposes. So far the whole examination of the contents of the abdomen after they have been removed on to the tray takes not more than one minute.

Should the inspector, however, discover in his examination of the glands any evidence of tuberculosis or other disease, he makes a mark with his knife—or in some other way which may be devised—indicating that the contents of the abdomen are condemned as unfit for food, and these are then removed to the destructor.

Inspection of Lungs, Liver, Heart, and Head. While the inspector has been turning his attention to these abdominal organs, those who are dressing the carcase have removed the contents of the chest, and these are hung on an adjacent hook, either on the wall or a pillar. This hook bears *the same number as the apparatus from which the carcase itself is suspended.* In this way when the inspector comes to examine the lungs, liver, and heart, as well as the head, he knows exactly from *which carcase they have been taken,* a point of the very greatest importance.

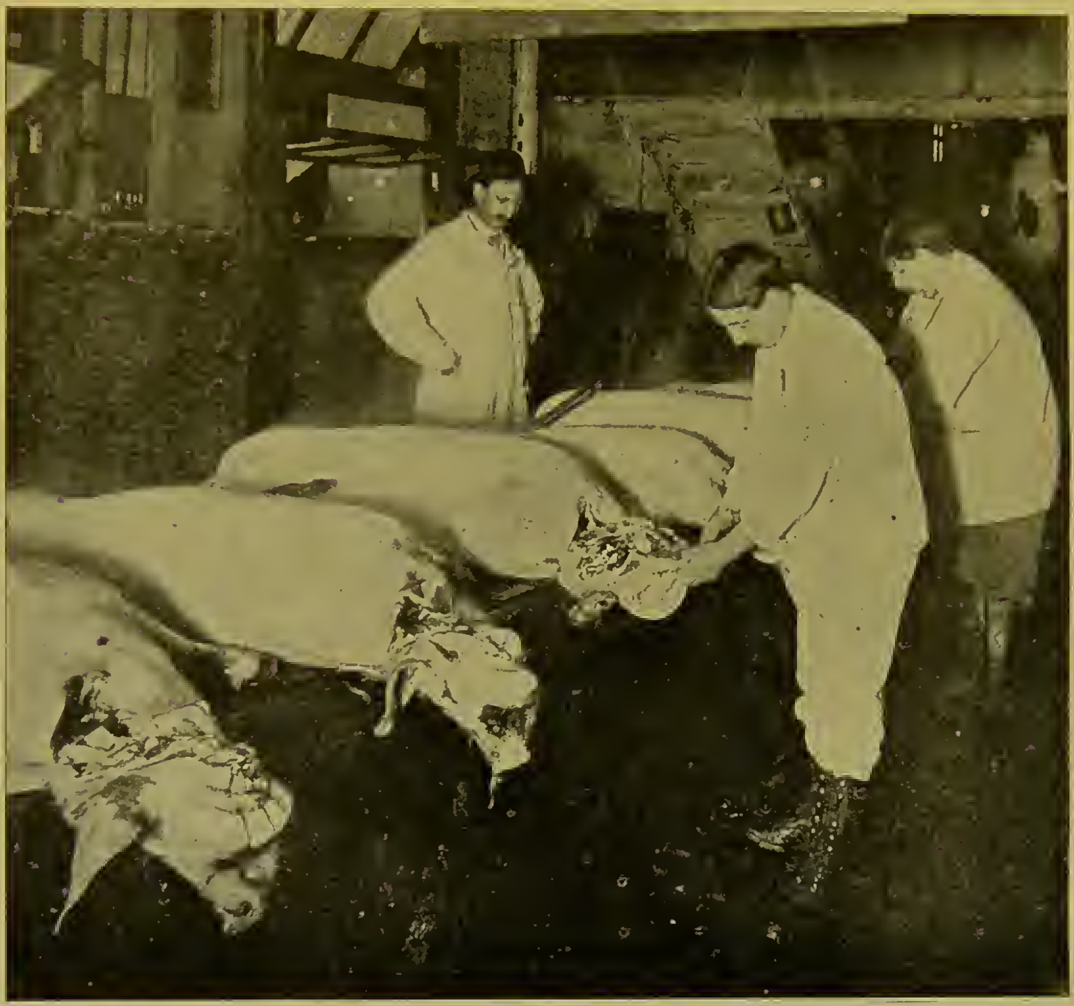
He then turns his attention to these organs, examining first the head in those cases in which, as in cattle for example, the head is severed from the body in dressing the carcase. In this country very little attention is usually paid to the examination of the head, but the muscles of mastication should be carefully incised both inside and outside the cheek to ascertain the presence or absence of *cysticerci*, this being one of the seats where the cysts are most commonly found. The incision should be made parallel to the bones of the jaw, turning back the muscles like a flap. The tongue is then examined, being well depressed and pulled down. The various glands in the mouth are incised and examined to ascertain the presence



DISSECTING-TABLE

or absence of tuberculosis, and the whole head, being found healthy, is stamped as before both on the tongue and on the outside, and may then be removed as convenient. This examination also takes not more than one or two minutes, if as much.

On the next hook bearing the same number will be found hanging the trachea, the lungs, the heart, and the liver belonging to the same animal, and to these the inspector now turns his attention (pp. 777, 778, and 781). The slaughterer, before hanging them up, should have sliced open the two ventricles of the heart and quickly and lightly washed out the blood contained, leaving only the evidence of changes which are produced before death. The inspector examines the heart especially for the presence of cysts in the muscles, or for septic inflammatory conditions. The examination of the liver is both external and internal. Frequently without any incision at all, conditions are quite obvious which cause it at once to be condemned. In addition, the inspector makes an incision across the bile-ducts especially to notice whether they are or are not affected with fluke, and the gland at the hylum is examined for tuberculosis, the exact method of handling being shown in one of our illustrations. In localities where the liver is held in great demand as a food-stuff, and



INSPECTION OF THE GLANDS IN PIGS (AMERICAN)

therefore possesses considerable value, any small abnormalities on the surface may be removed with the knife ; but if any large lesion be present the whole organ must be condemned at once.

Too much care cannot be bestowed upon the liver. Of all organs in the body, it is the one that reacts most readily to degenerative changes and which will most often require seizure.

How to examine Lungs. The lungs next demand notice, together with the glands lying between them and in relation to the gullet. These are carefully incised and observed, and the inspector, handing his knife to an assistant who stands beside him during all examinations, seizes the lungs in both hands, passing his hands from above downwards, squeezing the mass as he does so, a process which reveals *to the touch* any solid, hard, or fluctuating areas in the organs. After a certain amount of practice the inspector becomes very sensitive to the physical conditions which can be felt in the lungs by the hands, and often gains information in this way which otherwise would be overlooked. Then taking his knife from the assistant, an incision is made deeply across each lung. The slightest sign of tuberculosis, either on the surface or in the interior, is,

of course, sufficient to condemn the whole lungs. In the absence of a lesion at all these organs, together with the liver and heart, are stamped as passed, and the examination of the organs of that particular carcase is completed. Very few minutes are required to undertake this procedure, which is represented in various illustrations in these pages.

General Inspection of the Carcase. By the time the inspector has examined all these organs, the carcase itself is ready for his attention. He walks round it as it is suspended or else has it turned round on its pivot, while he takes a general view of the external surface, noticing as he does so the presence or absence of bruises, contusions, and so forth. Then, standing in front of the carcase, he carefully inspects the abdominal and thoracic cavities, particularly with a view to the detection of any signs of *inflammation* or *tuberculosis*. At the same time he looks carefully

Demonstration- and Dissecting-room for Diseased Animals, as arranged at Hamburg

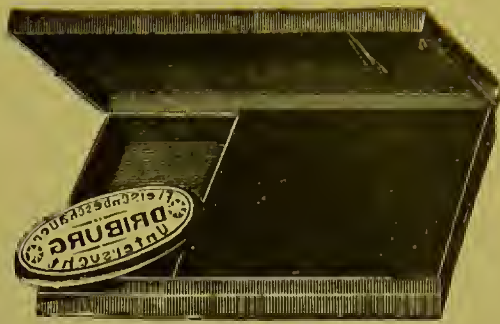
at the condition of the fat, especially in the region of the kidneys, and also is careful to lift up the diaphragm, under which are often found signs of pleurisy and tuberculosis which are less prominent elsewhere. If the lining membranes of the abdomen and thorax appear perfectly healthy, and nothing has been found in the previous examination or any of the organs belonging to this particular carcase, it only remains for the inspector to be satisfied of the healthy condition of the muscle itself in order to complete his inspection.

Detailed Inspection of Glands, &c. On the other hand, however, should there have been evidence of the existence of tuberculosis in the lungs or elsewhere, or should he have now found such evidence in the carcase, it becomes necessary to make a further examination of *the various glands* in the different regions, with a view to deciding what is to be condemned and what to be passed, provided that there is some option left to the inspector in that matter. In this examination he will examine the maxillary, the mammary, the inguinal, the crural and the prescapular glands, in any or all of which tuberculosis may be present in advanced cases ; and he will base his final judgment of the carcase on what he finds in these respective situations. The *kidneys* are not usually cut into unless there is some reason to suspect the presence of disease ; but it is well to take a careful look at some of the *bones*, especially the vertebræ, in connection with tuberculosis.

All this detailed examination for tuberculosis—which, however, takes a very short time to perform—is not necessary if the inspector is working under such local or sanitary regulations which demand the destruction of the whole carcase or certain parts in the case of any tuberculosis ; but if the regulations permit some degree of latitude in the matter, then these points become of the very greatest importance. Further, they are here stated in detail because, in the opinion of the writer, *a very large amount of sound and safe meat is condemned and destroyed in Great Britain which is perfectly fit and safe for human food.* There ought to be a much wider discretion given to the inspector in this matter, which, however, demands first of all that the inspector be a thoroughly competent man scientifically trained for the purpose. In continental countries, where the institution of the Freibank is in operation, this detailed examination, in order to preserve such parts of a carcase as are fit for food, is a matter of great sanitary and economical importance.

Inspection of Pigs. We may now turn our attention to the inspection of the section of the slaughterhouse devoted to pigs, remembering at the same time that the pigs will have been inspected already upon their arrival at the slaughterhouse for any signs of injury or infectious disease. They have then been slaughtered by one or other methods previously described, and have undergone one of various processes for the removal of the bristles. The inspector's further duty does not begin until that is complete. Inspection should then follow upon lines very similar to those already laid down for cattle ; that is to say, that the internal organs are removed, the mesenteric glands incised, the heart, lungs, and liver

Pocket Pad for Meat-stamping



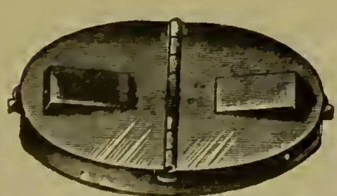
Meat Stamp with Pad in Box

examined as before, the only difference at this stage being the *special examination of the head.* In the case of the pig, of course, the head is not severed from the body, and the examination of the glands in the mouth and neck is done at the same time as that of the carcase itself.

This point is of great importance on account of the fact that tuberculosis in the pig is much more readily generalised than in other animals, and the examination of the glands in the region of the mouth rarely fails to show it if present.

India-rubber Meat-marking Stamp

Special Examination for Trichinosis. There is one disease, however, which in certain parts of the world, and in certain districts especially, calls for a method of inspection peculiar to itself. That disease is *trichinosis.* It is not customary in this country for a systematic search to be made for the parasites which cause this condition, but it is necessary in some places and it might become necessary at any time, and therefore the procedure should be known by every inspector of meat. It requires a certain amount of technical skill and considerable practice in order to become rapidly efficient, but presents no difficulty to any ordinary intelligence. We may take as a type of inspection for trichinosis the procedure adopted in a slaughterhouse such as that of Gothenburg. This is carried out in the following manner. Six small portions of muscle are cut from the pig in question by the inspectors and placed in a small, flat, circular dish about three inches in diameter and half an inch deep, the top of which is stamped with a number. This number corresponds to the number which has already been placed upon the carcase of the



Pocket Pad for Meat-stamping

Hamburg Meat Stamp

pig from which the portions have been taken. The situations from which these portions of muscle are cut are as follows: two from the muscles of the larynx, two from the pillars of the diaphragm, and two from either side of the kidneys (the psoas muscle). When a certain number of these tins have been filled with the portions of muscle, they are sent to a special room for microscopic examination. (In the case of Gothenburg this examination is carried out by women at the slaughter-house who are specially trained for this purpose, and who do nothing else.) A portion of each piece of muscle is snipped off by means of fine scissors, placed upon a large glass microscopic slide upon which is a little distilled water, and the muscle-fibres are then teased out and then pressed by pressing another slide upon the first. The preparation of such a specimen in the manner stated takes less than three minutes. The slide is then placed upon the stage of the microscope and moved by the operator in a definite way from before backwards and from side to side, until every portion of muscle upon it passes under the lens. The presence of the parasite is then readily detected.

How Careful Examination is secured. It will readily be understood that in those slaughterhouses where trichinosis is a very rare disease this daily labour is almost invariably negative in its result, and the consequence of this is that those who examine this muscle would be apt to become very careless from passing many days in succession without discovering or seeing any sign of the parasite. To overcome this inevitable result a rather ingenious system is adopted in Sweden. Every now and then a portion of trichinosed muscle is deliberately put into one of the tins by the inspector, who carefully notes the number of the tin into which he placed it. Should the meat in that tin be subsequently reported as free from the disease, it means, of course, that the microscopist has failed to observe it. For this fault the unfortunate operator has a sum of ten kroner (about eleven shillings) deducted from that week's wages, which we imagine would not leave a very large balance. It is only fair to add, on the other hand, that a similar sum is added for every case of the disease which is detected. It might be thought that this would constitute a very generous proceeding on the part of the Swedish Government, but as a matter of fact trichinosis occurs there in only one out of every 100,000 pigs which are examined, so that the bonus ought not to prove a severe drain upon the exchequer.

The Question of Private Slaughterhouses. We have already intimated in a former chapter what we consider to be an ideal system of the arrangements in a public slaughterhouse. There is, however, no use attempting to blink the fact that one very often has to deal with circumstances as they are found, and not with conditions which are theoretically ideal. Moreover, in this matter of the meat industry it is to be remembered that we are dealing with a trade and interest which, whether regarded from the financial or commercial standpoints, can only be described as colossal. It is therefore worse than useless to dogmatise about this, that, or the other way in which things ought to be or might be done without at the

same time honestly and candidly looking at the circumstances of the industry as they actually exist. It would be a tremendous mistake in the interests of all concerned to attempt to force systems of administration upon unwilling recipients, as far as Great Britain is concerned. For one thing the attempt would be foredoomed to failure—the national character is sufficient to prophesy that. It is somewhat different in many other countries, where every branch of national life is regulated down to its most minute detail by municipal and govermental regulations and authority. We are too accustomed in this country to leaving a great deal to the enterprise and common sense of the individual, and it is quite a question as to just how far that should be interfered with. It really becomes a problem which has to be decided ultimately in the interests of the public at large, and the great difficulty in this particular problem is the absolute lack of uniformity in the regulations and methods adopted in the various large centres of the meat industry. When it comes to the smaller centres, and especially the very small traders, the difficulty is immensely increased.

Difficulties of a Uniform System. It sounds very easy to say that in the interests of the general public and of the whole community there should be one uniform system of slaughtering and meat inspection all over the British Isles. That would be an ideal state of affairs. But the unfortunate part of the whole thing is that some parts of our country are so immensely ahead of other parts in their existing arrangements that they would resent being dealt with on the same lines as others. It is exactly the same as if one were to deal with an honest man and the rogue in the same way under similar circumstances. The honest man resents that, and quite naturally. Still, that does not do away with the fact that the rogue exists, and the public must be protected accordingly. If it were not for this factor of the personal integrity of the trader, the problem would be comparatively simple, instead of which it is an extraordinarily complicated one. We wish to be perfectly frank about this matter and to place every aspect of the question impartially before our readers, who, it is not too much to say, will be called upon before very long to take their part in the developments of meat inspection which are bound to take place in this country as in all others.

Examples of Lack of Uniformity. With that purpose in view we may take two imaginary cases, or rather cases drawn from actual experience, but which need not be particularly identified for the purposes of our present argument. In the first case here is a city which we may call "A"—a large centre of meat industry, in which trade some millions of money are concerned, and in the carrying out of which many thousands of people are employed. The industry has been situated in this city for generations. Many of the men engaged in it have inherited their respective businesses from their fathers, and it is the main object and interest of their lives to make those businesses as up to date, and as high in the reputation of the public, as they possibly can. To this end those engaged in the trade have many years ago organised themselves into a trade

association, the objects of which association are to watch over the interests of their business in every possible way. As time has gone on the meat inspector has come upon the scene and has had to be reckoned with. The officials and members of the trade association, who, be it remembered, exist for the furtherance of all that is honest and straightforward in their business, have been quick to recognise that in the meat inspector they have a valuable friend. He has therefore been welcomed by these men with open arms and is consulted by them on every possible occasion. Should any member of this association slaughter an animal in his private slaughterhouse, or in his booth at the public slaughterhouse, the absolute fitness of which animal for human food is at all doubtful, he immediately sends for the inspector and submits the carcase for his judgment. Whether the carcase is condemned or passed is not the point. The point is that the meat-purveyor and the meat inspector are working hand in hand for the protection of the public and for the integrity of the industry. Obviously it is quite possible—and indeed in this case it happens—that a staff of three or four inspectors can perfectly well overcome the work in a city of hundreds of thousands of inhabitants. The reason is that those engaged in the industry constitute such a powerful guarantee that the industry is carried out on a proper basis, that the authorities are to a great extent relieved of the responsibility which would otherwise fall upon their shoulders. The meat-purveyors realise that it is to the interests of their own business that that business be maintained at a high standard of honesty, and that the public shall be as well served as possible. That attitude of mind has only been attained in the trade of such a city because of the personal character of those who have been responsible for the formation and the administration of the trade association. Were that the attitude of mind of all business proprietors, there would be precious little need for all the regulations which exist. As far as our personal inquiry is concerned, there is nothing whatever to be said against the existence of the private slaughterhouse owned and worked by the individual meat-dealer whose membership of his association and whose standing with his fellow-men in his own city depend upon the carrying out of his business in such a manner as is approved by those associated with him. This is the man who resents very strongly, and very naturally, being told that for the safety of the public he must conform to a universal system of national inspection. He is apt to take it as a reflection upon the manner in which he conducts his business, and he is very apt also to forget that there are other traders in his own business who are not so honest as himself, and who are not at all above dealing in an inferior article if they can do so without any risk to themselves.

Dealers in Inferior Meat. On the other hand, let us consider the case of another city, " B," which cannot be described in any sense as an important centre of the meat industry, except in so far as, in common with all other cities, it contains a number of people whose business it is to provide meat for the feeding of the population. Here the money invested in the industry and employed in it is probably only reckoned

in hundreds instead of thousands as in the previous case, and there is no traders' association or any other organisation which controls the business. Every man works independently and solely for his own interests. There is no organised system of meat inspection, and there is no municipal slaughterhouse. Every meat-purveyor has his own private slaughter-house, where the work is carried out just as he thinks fit, which very often means under extremely dirty conditions and attended with considerable cruelty. The traders, for the most part, are small dealers who kill their cattle at a dozen at a time or even less, just as their immediate requirements demand. The cattle themselves are derived from all kinds of sources, and their quality is usually second rate, if not worse. Indeed, it is well known amongst a certain class of cattle-dealers that while it would be a waste of time to send these cattle to the markets of the city previously described, where they would be immediately seized as unfit for food, they have a very good chance of disposing of them without any trouble in the centre at present under notice. As a matter of fact, the meat sold in town " A " is of the highest possible quality that can be got, whereas in town " B " it is just the reverse. True, in the latter case it is cheap, cheaper than in the former city, because of its inferior quality.

The Problem. Now it is, unfortunately, this second instance which is relatively frequent and which demands attention. Rather, perhaps, it would be more accurate to say that it is traders such as are described in the second case who are responsible for the demand for adequate systems of inspection. It is not very frequently that they comprise the whole of this industry or of any industry, but it is almost general to find in any and every large centre a certain number of dealers who deliberately set themselves to carry on a business in inferior goods. Such a business, of course, may be in some cases a perfectly legitimate one. There is not the slightest reason in the world why a man if he chooses shall not make his business the selling of cheap boots or cheap lead pencils or cheap paper, or many hundreds of other cheap kinds of goods, so long as he distinctly sells these articles as being none other than as described. By providing them for those who require them, he meets a perfectly legitimate demand in a perfectly honest way. The case is far different, however, when it is a question of supplying pure food of a high quality for human consumption. No meat-purveyor in this country deliberately tells the public his meat is inferior, or advertises his goods as of second or third rate or any inferior quality. Still less does he ever tell his customers that they can only have this or that joint at such and such a price because the carcase from which it was cut would, in perhaps a neighbouring town, have been seized and condemned as unfit for food.

How to protect the Consumer. The problem, therefore, which concerns those who will ultimately have to settle the regulation of the meat trade is how to protect the public from the unscrupulous trader, without at the same time interfering unduly with the arrangements and the interests of the dealer whose integrity is above suspicion. There does not seem to be any way out of this problem except a system which applies equally

both to the just and the unjust dealer, though it is, of course, extremely difficult to introduce meat inspection on uniform lines where the meat inspector is regarded, on the one hand as a friend, and, on the other hand, as a detective. It is, of course, the frequent occurrence of the second class of trader which will make the demand for universal meat inspection, and which will ultimately cause the abolition of the private slaughterhouse. It will, in our opinion, be decided by the honesty of the majority of those engaged in the business, or the success which attends the efforts of the dishonest to evade the law.

We have been told by some who have very large interests at stake in this matter that the abolition of a private slaughterhouse would spell ruin to them, for the simple reason that the cost of transporting the hundreds of carcases per week, for example in the case of pigs, from a central public slaughterhouse to the private works where the carcases are dealt with, would mean the ruin of the industry.

We have been furnished with actual figures of the cost in such cases and are not prepared to dispute them, although, at the same time, it must be said that such a system in other countries has not been attended with any such disastrous results. At the same time, the hostility of those engaged in the trade in those cities where the business is thoroughly well organised and administered by responsible men, is a factor of immense importance and one which cannot be overlooked.

A Difficulty that can be overcome. The difficulty, however, is one which is by no means impossible to overcome. It might be managed, for example, in this way. At the present moment the private slaughterer has to erect his slaughterhouse at his own cost, maintain it in a good condition, keep it in thorough sanitary state, and employ his own workmen for the various purposes for which they are required. In a public slaughterhouse all that is done for him by the municipal authorities, in return for which he pays an annual rent to the city proportionate to the amount of space in the slaughterhouse required for his business. If he desires, as he does, to retain his own private slaughterhouse and keep his own business entirely in his own hands, all that is necessary is to suggest to him that he should pay a certain sum towards the salary of the meat inspectors in his particular city. That would probably be no more, if as much, as he would be required to pay if he had meat out of the public abattoir, while at the same time it would enable the municipality to employ an adequate staff of inspectors—a staff sufficient to ensure the thorough inspection of every slaughterhouse in the area concerned. The present writer made the above suggestion to a very large dealer who raised the objection above mentioned ; and the dealer in question, who strongly resented any prospect of being deprived of the right of slaughtering in his own slaughterhouse, expressed the opinion that such a system would meet the difficulty perfectly well. It may, therefore, be commended to the serious consideration of those whose business it is to administer these matters. The whole point is to secure adequate protection for both public and traders. The precise details

by which that protection is secured can be, and should be, perhaps, matters of special arrangement according to the needs of customers of the various districts concerned. It is perfectly possible, though doubtful, that in a country like our own, and with a national character such as ours, a uniform system applied identically everywhere would not be successful, or, at any rate, would be extremely difficult to introduce and administer.

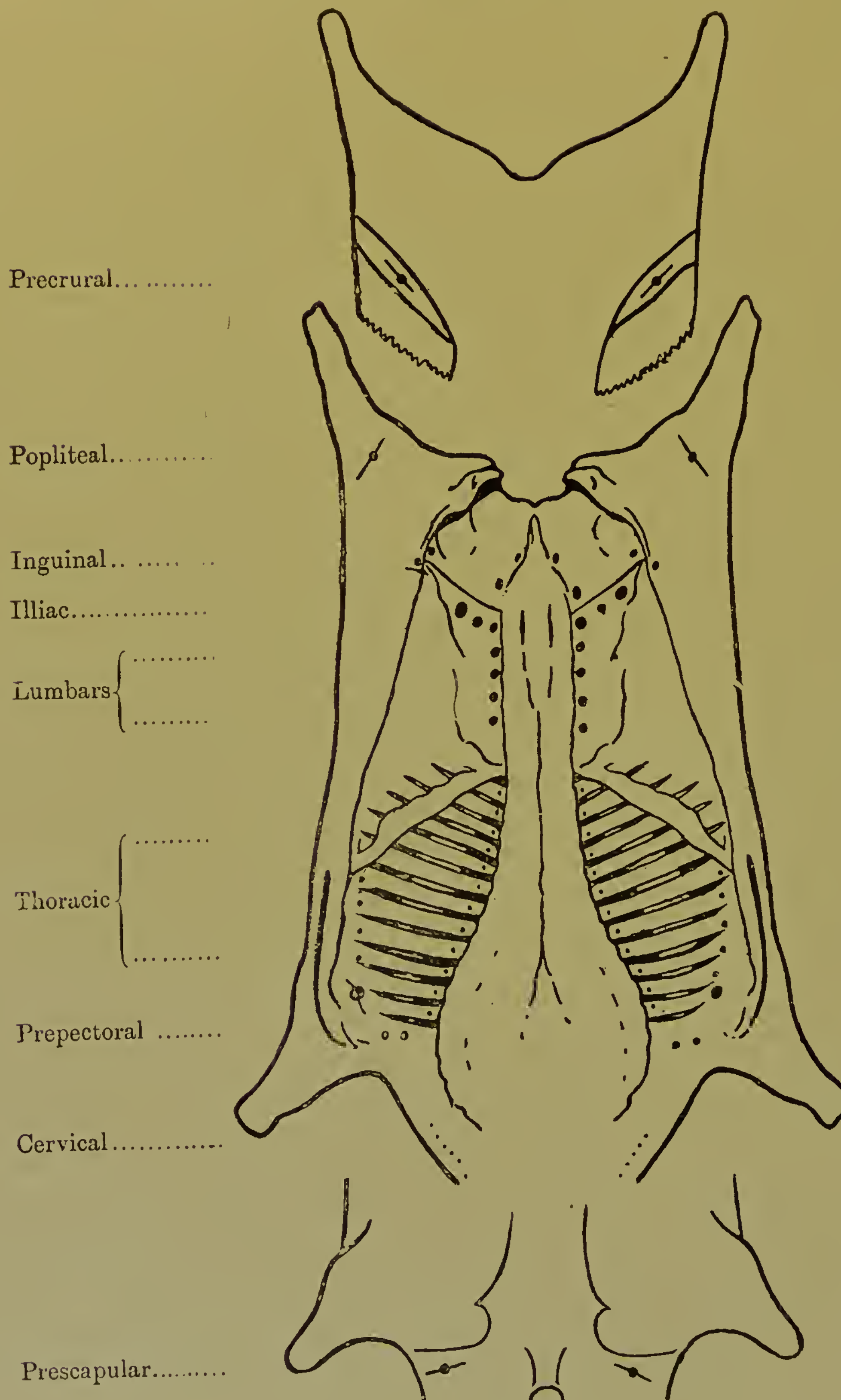
If that view be taken, then we maintain that still it is perfectly possible to devise other plans by means of which there shall be an absolutely safe and adequate system of meat inspection, of which the above solution is, at any rate, one, and many other solutions might be found.

The Fate of the Private Slaughterhouse. Finally, it might very well be dealt with on lines which gradually and by degrees allowed the private slaughterhouses to die a natural death as the smaller traders cease to exist. That is to say, it would be perfectly fair and reasonable to refuse to allow any new private slaughterhouses to be erected *unless the owners were willing to pay their share of the cost of maintaining an efficient staff of inspectors.* The result of such a system would probably be that as towns grew in size and population, and the meat industry thereby increased with the town, it would be found more and more economical and satisfactory to all concerned to establish a municipal central slaughterhouse for each city as it became sufficiently large to warrant it. As far as the country and rural districts are concerned, as we have already suggested elsewhere, a perfectly satisfactory system of meat inspection can be established by the very simple process of making each veterinary surgeon a Government meat inspector, whose business it should be to inspect all the slaughterhouses periodically in his district.

INSPECTION OF LIVING ANIMALS

In almost all civilised countries to-day, meat inspection, as far as carcases which are slaughtered for food are concerned, has been or is in course of being placed on a scientific basis, but it is a somewhat curious fact that in these same countries the necessity of attacking this problem at its source of origin is being somewhat tardily realised. After all, it would be far better and ultimately *far cheaper to prevent diseased animals being slaughtered at all or even grown* than it is to breed all kinds of good, bad, and indifferent animals, each and every one of which has ultimately to be inspected. In our opinion the ultimate solution of the pure meat question is to be found here, namely, in a perfected system of examination of living animals at the farm or other places where they are being brought up. An attempt has been made in this direction by the Government of Holland, to their credit be it said. In that country an Act was passed in the year 1904 with the object of providing facilities and means for the eradication of tuberculosis amongst the Dutch cattle.

How to eradicate Tuberculosis. The *modus operandi* is as follows: In the event of any farmer or stock-raiser suspecting tubercular disease in any of his animals, he is enabled to report his suspicions to the local


Precrural
Popliteal
Inguinal
Illiac
Lumbars
Thoracic
Prepectoral
Cervical
Prescapular

Carcase of .... Age................ Slaughtered........................

Owner ....

Condition...

Head Glands, Pharyngeal.................................

Submaxillary.. Parotid.......................................

Lungs—	Right.	Left.
Surface	....	....
Substance	....	....
Glands, Bronchial	....	....

Anterior Mediastinal......................... Posterior Mediastinal..............

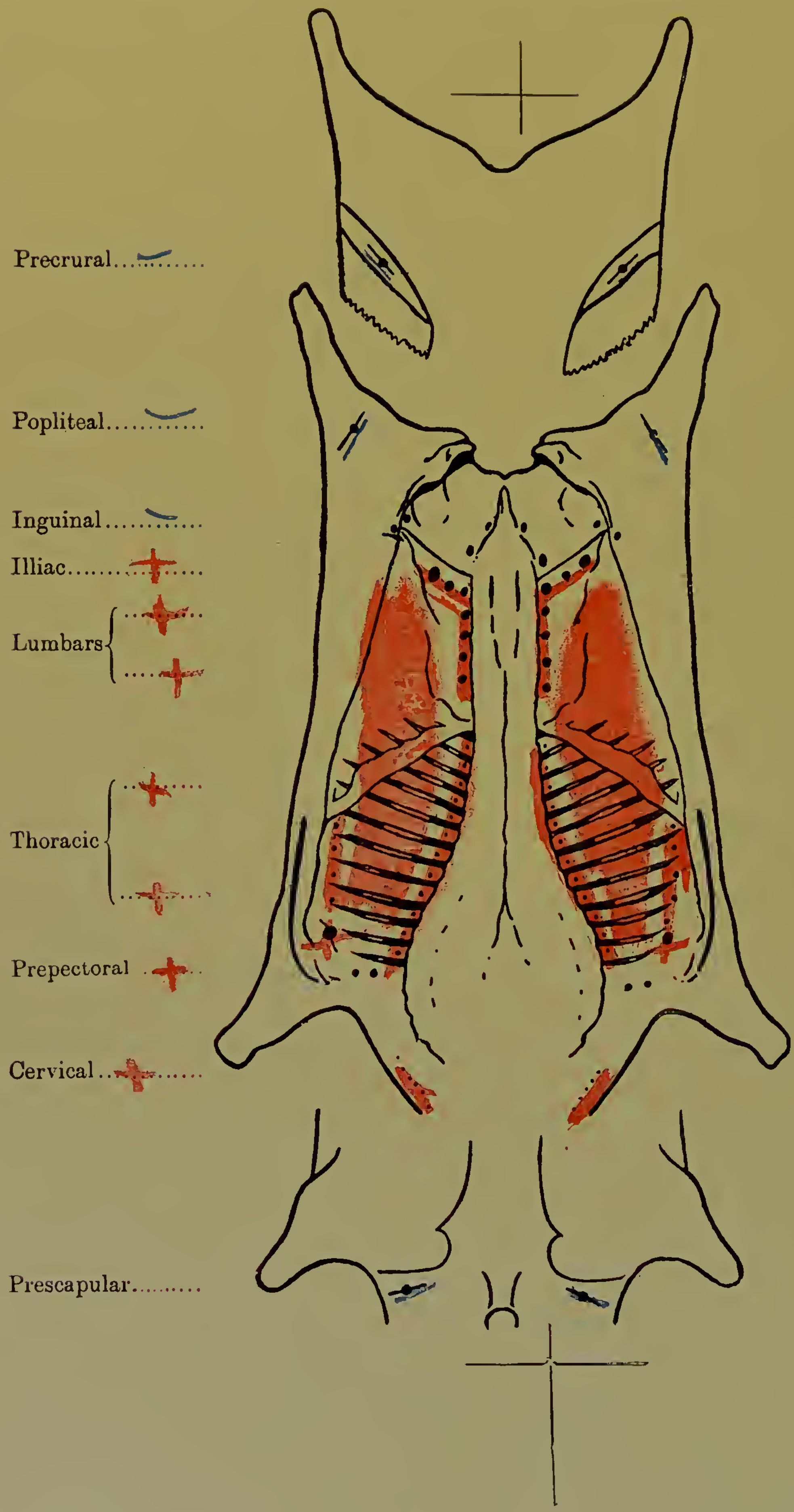
Heart, surface	....	Glands	....
Liver, surface	....	Substance	....
Glands	....		
Stomachs, surface	....	Glands	....
Intestines, surface	....	Glands	....
Spleen, surface	....	Substance	....
Uterus, surface	....	Interior	....
Udder, substance	....	Glands	....

Quarters affected...

Remarks...

Decision...

Date.................................. ....


Precrural
Popliteal
Inguinal
Illiac
Lumbars
Thoracic
Prepectoral
Cervical
Prescapular

Carcase of cow Age d Slaughtered –/–/09

Owner — —

Condition Fair

Head Glands, Pharyngeal —

Submaxillary — Parotid —

Lungs—	Right.	Left.
Surface	+	+
Substance	+	+
Glands, Bronchial	+	+

Anterior Mediastinal + Posterior Mediastinal +

Heart, surface	—	Glands	—
Liver, surface	+	Substance	+
Glands	+		
Stomachs, surface	+	Glands	+
Intestines, surface	+	Glands	+
Spleen, surface	+	Substance	—
Uterus, surface	+	Interior	—
Udder, substance	—	Glands	—

Quarters affected

Remarks Very heavy deposit (tubercular) on both pleura & peritoneum

Decision Totally Condemned

Date –/–/09

authorities, who instruct the government veterinary inspector to visit the farm and apply the tuberculin test.

All animals which are found to react are slaughtered, and the market value is paid in full to the owner whether they be found tubercular or not upon post-mortem examination. Those that are found to be free from disease are of course sold, after passing the inspector in the usual way. There can be no doubt that this beginning is in the right direction, and if it is gradually extended, as it probably will be, we may look forward to a very rapid diminution in the number of tubercular carcases in those areas where it is adopted. The further preventive measures to be taken in order to produce a tubercular-free stock consist in the sterilisation of milk before it is given to calves or pigs as food. As we have already seen in another part of this work, the vast majority of cases of tuberculosis in animals arise by infection through contaminated food, and if by any system, such as the means above suggested, the young calves and pigs can be protected from infection, it means that the total loss from condemned meat would be very soon reduced to a minimum and the saving to the cause of agriculture would be immense. It is probably not too much to say that the proportion of cases of tuberculosis which figure in the condemned lists throughout the country is as great as nine out of every ten carcases condemned.

Recording Results of Inspection. In addition to securing a thoroughly scientific method of inspection, it is also extremely important that the results of such inspection should be kept in a systematic way so that they may readily be referred to by the public health authorities and others to whom the statistics and facts are of importance or interest. For this purpose in all well-regulated abattoirs certain books are kept in which entries are made recording the condition of each animal or part of an animal which the inspector has seized. These books are kept in an office, and the entries are made either at the end of the day's work or at such odd moments when the inspector is not otherwise engaged. As the result they frequently suffer in accuracy and detail on account of the haste with which the entries have to be made, and partly also from the forgetfulness of small facts of which the inspector has lost sight in the interval. We therefore consider it to be of great importance that the inspector should be provided with some kind of book or printed form which he should fill in *at the moment of inspection* in the slaughtering-hall, while he is in the actual presence of the carcase he is describing. This system is adopted in some continental abattoirs, in which pages of a note-book are divided into parts under different headings in which blanks are left for the inspector to fill up as he goes along. From these note-books, which can be carried in the pocket of his coat, the permanent and the more elaborate books of reference are afterwards compiled. This system has many advantages besides that of mere accuracy for statistical purposes. It ensures, for one thing, a much more thorough observation on the part of the inspector, since it is necessary for him to fill up all the details of the form in connection with any carcase which he is about

to condemn. It also adds greatly to the educative value of his work because it compels him to observe as a routine practice all the organs and glands in a definite order. It is pleasing to be able to record that such a system is not unknown in this country since it is carried out by the inspectors in the public health department of Hamilton, in Scotland, under the management of Dr. John Wilson, M.O.H. Dr. Wilson, some years ago, supplied his inspectors with an extremely useful form of the nature just referred to, which has on it a rough diagram of the carcase together with indications on the diagram of the positions of the various groups of glands whose condition is to be noted. The system adopted in Hamilton is to enter all tubercular lesions in red pencil and to colour that portion of the carcase red which is also affected. Thus if any portion of the carcase is condemned the exact area condemned is shown by the red colouring. Other portions of the carcase which are not affected are either left blank in the report or marked by a dash in a blue pencil. The simplicity and fulness of detail which this excellent method gives can be the better appreciated by a simple reference to Dr. Wilson's sheet, two copies of which are here appended. The first of these is left entirely blank to show the sheet as supplied to the inspectors; the second is filled up for a definite case to show exactly how it is meant to be used. We would strongly urge the adoption of some such similar proceeding in all abattoirs in the country (*see* pp. 804–807).

Final Record of the Results of Inspection. It is of great importance for many reasons that accurate and detailed statistics should be available in all branches of the meat industry, and in no branch is this more important than in that of the results of the inspection of carcases in public and private slaughterhouses. In most corporation abattoirs a book is provided for this purpose, in which the inspectors or superintendent make the requisite entries. It often happens, however, that the system of entry is far from satisfactory, as a rule being deficient in detail. In order to show how such a system should be carried out, we reproduce the following sheets from the records of inspection in Salford for the first nine months of 1909, for which we are indebted to the Veterinary Inspector, Mr. Joseph Whitehead, F.R.C.V.S. The tables speak for themselves as regards their arrangement. Commenting upon these particular figures, Mr. Whitehead says: "The large number of seizures at the public slaughterhouses are due chiefly to animals from the railway (entered under asphyxia) and to cows sent to the slaughterhouse from the cattle-market. I may mention that of the seizures of tuberculous pork, out of one consignment of 216 carcases of pork to Salford, forty-one were found to be tubercular. In another case of tuberculous pigs which had been fattened at a creamery, the potted cream from this factory was also found to cause tuberculosis. In a third case, where pigs from two separate farms were found to be affected with tuberculosis, the farmers were cheese-makers, and the county medical officer of health was informed, and on the farms being visited by him, several cows were found with tubercular udders."

METHOD OF RECORDING

Month.	No.	Beef.		No.	Mutton.		No.	Pork.		No.	Veal.
		Wt.	Disease.		Wt.	Disease.		Wt.	Disease.		Wt.
1909		Lb.			Lb.			Lb.			Lb.
January .	4	1190	Tubercle	36	1372	Asphyxia	23	644	Tubercle	2	80
	1	85	Congested	10	51	Congested	2	188	Asphyxia	1	35
	1	850	Choked	1	4	Parasitic				1	5
	1	10	Abscess	7	30	Fluke					
				1	2	Abscess					
				13	530	Dropsy					
				2	116	Injured					
				2	8	Decomposition					
February .	6	1141	Tubercle	20	1422	Asphyxia	5	141	Tubercle	2	95
	1	100	Congested	10	52	Congested	2	4	Pleurisy		
	1	16	Fluke	13	576	Dropsy	2	24	Parasitic		
	1	400	Cystic	2	110	Decomposition					
	1	52	Septic pericarditis	4	16	Fluke					
	1	420	Dropsy	4	108	Injured					
	1	480	Emaciation								
	2	28	Fatty degeneration								
March .	11	1471	Tubercle	46	2490	Asphyxia	10	478	Tubercle	1	40
	1	30	Injured	2	14	Congested	2	380	Asphyxia		
	1	100	Congested	1	35	Dropsy					
	1	20	Echinococcus cysts	1	35	Decomposition					
	1	14	Fluke	1	8	Injured					
	1	25	Actinomycosis								
	2	30	Fatty degeneration								
	1	500	Asphyxia								
April .	5	1100	Tubercle	17	886	Asphyxia	2	680	Tubercle	2	60
	1	10	Echinococcus	2	10	Congested	5	50	Pleurisy	1	8
	1	35	Actinomycosis	2	122	Dropsy	1	130	Icterus		
	2	32	Fatty degeneration	1	30	Injured	1	10	Congested		
	1	460	Sarcoma	1	4	Fluke	1	8	Parasitic		
May .	8	1818	Tubercle	13	660	Asphyxia	1	2	Nephritis	1	66
	2	70	Congested	3	16	Congested	1	8	Pneumonia	2	12
	1	14	Angioma	1	40	Dropsy	1	56	Congested		
				2	120	Decomposition	1	140	Asphyxia		
							47	5110	Tubercle		
June .	9	2154	Tubercle	7	300	Asphyxia	5	495	Tubercle	3	200
	1	14	Fluke	1	40	Dropsy	1	100	Swine fever	1	50
	1	420	Dropsy								
	1	30	Actinomycosis								
	2	23	Septic nephritis								
	1	30	Milk fever								
July .	7	936	Tubercle	14	554	Asphyxia	6	122	Tubercle	1	50
				2	35	Pleurisy				1	20
				1	8	Injured					
				1	8	Fluke					
				1	8	Decomposition					
August .	25	7138	Tubercle	13	546	Asphyxia	3	32	Tubercle	1	40
	1	40	Abscess	2	21	Fluke	1	340	Swine fever		
	1	25	Fluke	1	30	Dropsy	1	10	Cirrhosis		
	1	30	Pneumonia	2	80	Injured					
				1	11	Congested					
September	15	2038	Tubercle	1	40	Drowned	2	289	Tubercle	1	70
	1	20	Echinococcus cysts	1	12	Congested	1	8	Echinococcus cyst		
				1	42	Dropsy					
				14	600	Asphyxia					
October .	21	6755	Tubercle	18	674	Asphyxia	18	182	Tubercle	1	60
	1	100	Congested	4	126	Dropsy	1	100	Decomposition	1	50
	1	80	Injured	2	80	Injured					
	1	14	Cavernous angioma								
November.	36	10133	Tubercle	44	1787	Asphyxia	4	155	Tubercle	3	120
	1	30	Actinomycosis	4	142	Dropsy	1	10	Fibrosis	1	50
	1	20	Fluke	1	12	Echinococcus	2	350	Swine fever		
	1	60	Abscess	5	55	Fluke	3	27	Cystic		
	2	89	Congested	1	46	Injured					
	1	14	Cavernous angioma	3	128	Decomposition					
	1	480	Dropsy	1	50	Septic pericarditis					
	1	28	Echinococcus								
	1	80	Injured								

RESULTS OF INSPECTION.

Veal.		Fowl.			Fish.			Eggs.			Miscellaneous.	
Disease.	No.	Wt.	Disease.	No.	Wt.	Disease.	No.	Wt.	Disease.	No.	Wt.	Disease.
		Lb.			Lb.			Lb.			Lb.	
Asphyxia Dropsy Congested												
Asphyxia												
Asphyxia												
Asphyxia Echinococcus												
Asphyxia Congested												
Asphyxia Tubercle												
Tubercle Immature												
Asphyxia							1 box	500 (56 lb.)	Decomposition			
Asphyxia										3 brls. trotter	2128	Decomposition
Asphyxia Tubercle	2 (45 chicks)	106	Decomposition	1 box mackr.	56							
Asphyxia Decomposition				1 box mackr.	50		1 box	200 (25 lb.)				

BOROUGH OF SALFORD PUBLIC SLAUGHTERHOUSES

Number and Weight of Seizures

Month.	Beef.		Mutton.		Pork.		Veal.		Fowl.		Fish.		Eggs.		Miscellaneous.	
	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	We'ght.	No.	Weight
		Lb.		Lb.		Lb.		Lb.		Lb.		Lb.		Lb.		Lb.
January .	6	2,125	71	2113	2	188	4	120								
February .	12	2,609	53	2284			2	95								
March .	16	1,824	51	2582	1	240	1	40								
April .	8	1,605	23	1052			3	68								
May .	11	1,902	19	836			3	78								
June .	16	2,671	8	340			4	250								
July .	7	936	19	655			2	70								
August .	22	6,899	19	688			1	40								
September	16	2,058	17	694			1	70								
October .	24	6,949	24	880			2	110								
November.	45	10,934	59	2220			4	170				Mack-				
December .	Not complete.											erel.				
Total . .	183	30,512	363	14,344	3	428	27	1111								

PRIVATE SLAUGHTERHOUSES, INCLUDING SHOPS

Month.	Beef.		Mutton.		Pork.		Veal.		Fowl.		Fish.		Eggs.		Miscellaneous.	
	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.
		Lb.		Lb.		Lb.				Lb.		Lb.		Lb.		Lb.
January .	1	10			23	644										
February .	2	28			9	169										
March .	3	366			11	618										
April .	2	32			10	878										
May .					51	5316										
June .					6	595										
July .					6	122										
August .	4	334			5	382							1 (500)	56		
September					3	297									1 barrel trotters	2128
October .					19	282			2	166	1	56				
November.					10	542					1	50	1 (220)	25		
December.	Not complete.															
Total .	12	770			153	9845			2	166	2	106	2	81	1	2128

CHAPTER III

MEAT INSPECTION AND PUBLIC OPINION

UNDOUBTEDLY the greatest difficulty which we in Great Britain shall have to encounter in the next twenty years, during which we confidently expect that great endeavours will be made to put our own house in order in the matter of meat inspection, will be the dead weight of public opinion, which in this country moves so desperately slowly in connection with all matters of applied science. These matters depend so largely upon national customs and national temperaments.

The Continental Attitude. The continental nations have been accustomed for generations to being ruled in all their departments of life in a spirit of militarism, which has made the practical applications of scientific methods in various industries a matter of much greater facility than is yet possible in our own country. The attitude of the German people, for example, towards a question of this kind is entirely different to that of our own nation.

They would argue—as the result of their general mental training—that if we have a certain number of scientific expert men whose business it is to investigate these problems, to point out what should be done and what should not be done, the best way, and the worst way, to do it, all *we* have to do is to see that the recommendations put forward by these experts *are carried out* for the benefit of the community with the least possible delay and in the best manner possible, so long as municipal and national finances will permit. They would ask, What is the use of training an army of scientific experts unless we as a nation take the utmost advantage of their skill and knowledge? What otherwise are they paid for? The result is that in all these matters we are lamentably behind our continental neighbours, and this chiefly because of our different system of education and training.

The British Attitude. In Great Britain it is no use for the expert to say this or that is the best system of doing a thing, no matter how thoroughly he can prove his contention, and to expect that the public will immediately adopt his view. To begin with, he will probably find the greatest difficulty in getting those in authority to take the slightest interest in his proposals, though we are glad to say that phase is gradually disappearing, and more departments are being created by our Government, whose business it is to look after matters of this nature. But—and this is the real difficulty—before one can carry out any great scientific matters in this way in Great Britain, it is necessary to instruct and educate the *people as a whole* to such a pitch that *they will demand* from the authorities

the improvements which they have been convinced in their own minds are really desirable. In other words, the demand must come from the people *least informed*, and that demand requires a very long educative period before it becomes sufficiently imperious to receive attention. Reforms—no matter how urgent—cannot be forced down the throat of British public opinion ; public opinion has to be educated until it demands the reforms. We think too much of what we are pleased to call the liberty of the subject in these matters, a liberty which is too often interpreted to mean freedom to live in any undesirable way that the individual may prefer.

On the Continent, where the citizen looks towards his expert advisers for help, and accepts their advice as a matter of course, it has been perfectly easy, or, at any rate, not a matter of great difficulty, to establish a system of meat inspection which is uniform for the whole country and which works admirably. Few private slaughterhouses are permitted in Germany in any municipality which has established a public abattoir. Private vested interests, which are the great difficulties so often found here, are there pushed aside for the public good. Not only are the private slaughterhouses, which when they exist in such large numbers as they do in many of our large cities, and which make efficient meat inspection an impossibility, being done away with, but a most elaborate system of scientific inspection has been carefully devised, and is carried out with the very greatest care, and with little or no friction.

Further Precautions Necessary. The public slaughterhouse in itself is no guarantee of a pure meat-supply, though it instantly does away with many abuses, but its great advantage is that it makes good inspection a possibility, so long as no hole and corner slaughtering is allowed to be done outside. We quote elsewhere (*see* Vol. V.) the regulations for the inspection of meat which is intended for exportation to this country in Holland, and would draw the attention of our readers to the precautions taken in that country to ensure the discovery of any unfit carcases. The Dutch, however, have gone further than this, for not only have they the most elaborate system of inspection, but they are doing their best to *eliminate the disease* of tuberculosis itself amongst their stock. That is to say, they are attacking the evil at its source, and endeavouring to prevent not merely the sale of infected animals but the actual infection of the animals in the first place. This is done by the use of the tuberculin test on the farms, destroying infected animals and compensating the owners.

SUGGESTED IMPROVEMENTS IN SLAUGHTERING AND INSPECTION

A gratifying sign that the authorities in Great Britain are becoming fully alive to the very great importance of the many questions which have been discussed in these pages is to be found in the fact that so recently as 1908 Dr. Frederick Dittmar, Medical Inspector for the Local

Government Board for Scotland, was instructed to prepare a report on the extent to which slaughterhouses under public control had been established in Scotland and on the methods of meat inspection practised. In order to gather the material for this report, Dr. Dittmar visited a number of the larger towns personally, and obtained much information from others by correspondence with the local authorities. The results of this inquiry as regards the towns themselves are quoted elsewhere in these pages. The present writer carried out for the purposes of this work a similar personal inspection in the principal meat centres in England during the summer of 1909, the results of which are also given under the headings of the respective towns visited (Vol. IV.). Dr. Dittmar's report includes, however, not merely the results of his inquiries, in the form of a number of facts, but also suggestions which indicate in what respect he considers there is especial room for improvement. And since these suggestions of his, which are extremely valuable, are of much wider application than their merely local importance, it will be of advantage to note here their general significance. The following, therefore, is a summary of Dr. Dittmar's suggestions from the report mentioned, full details of which can be seen in the report itself.

The Question of "Driven Pork." At the present time the law is not very definite with regard to the liberty which exists to slaughter animals for human food, and it has been suggested that no such slaughter should take place of any animal which is intended to be sold in any but a licensed place, though at the same time the right to slaughter animals for private use should be retained in outlying districts, where it is not essential to erect special premises. The difficulty here consists in the fact with regard to pigs the flesh of which is intended for bacon and ham. The animals are often killed where they are fed. The carcases are then taken to the curing premises, which are usually in the towns. The objection given by the trade to utilise the public slaughterhouse for this purpose is that the quality of the meat is impaired by driving the pigs to the public slaughterhouse, in other words, that " driven pork " does not cure well. If this be so, the objection could be met by leaving the animals to rest at the slaughterhouse for two or three days before killing, or by transporting them thither in carts. Any additional cost incurred in this way, which might interfere with pigs fed by the poorer people, might be arranged by local administration. Any such change in the law should apply to the whole United Kingdom and Ireland.

Similar objections arise in connection with calves, but the voluntary arrangements which at present exist in Glasgow under which all carcases, calves, and pigs are inspected on arrival, show that it is possible to deal satisfactorily with this matter.

Establishment, Cost, and Control of Abattoirs. Owing to the more advanced state of public opinion in Scotland, there is a greater proportion of slaughterhouses under proper control than in either England or Ireland, and in order to increase this number the Local Government Board might be empowered by law to call upon all local authorities to provide such

premises where it was shown to their satisfaction to be required. The plans of such buildings, as well as the arrangements for administration and staffing, should be submitted to the Board for approval. "It is essential in the interests of the public health that public slaughterhouses should be instituted, and the cost of their upkeep forms a legitimate charge against the public health rate of the district they serve. A proportion, if not all, of the expenditure can be met by means of slaughterhouse dues, but, except in the large centres of population, these sources of revenue will not meet all the expenses of an efficient slaughterhouse service." In Dr. Dittmar's opinion, boroughs of over 6000 inhabitants are capable of supplying efficient administration for meat inspection, and he advises that in areas of four or five miles from any part of the boundary of the borough there should be no slaughterhouses except public ones.

Wherever a public slaughterhouse is erected all private slaughterhouses within the district served by the public one should cease to exist.

It would be a distinct advantage if power were given to two or more town councils to combine for the purpose of providing a joint slaughterhouse for their mutual use, there being no such power at present, and similar powers might also be given to enable combinations of districts to be formed for the same purpose. Dr. Dittmar even suggests that the Local Government Board should have power to compel local authorities to combine for this purpose, as they have in the case of providing hospital accommodation.

Slaughtering in Rural Districts. In scattered rural districts it is not necessary to erect public slaughterhouses. In such places the butcher's cart carries meat for many miles and a considerable amount of the meat-supply is obtained from town. But there is no reason why the killers of animals should not be *licensed* even in such localities, these men being at the service of all who desire to kill animals which are to be sold for human food. These persons should be paid by the local authority; those who employ them in turn should pay for their services; and in addition it ought to be their duty to report any unusual or diseased condition which they recognised as being present in any animal slaughtered by them. Such is Dr. Dittmar's suggestion. Our own opinion is, that, while we quite agree with the above as far as it goes, it would be better still in rural districts to appoint the nearest veterinary surgeon as meat inspector for that district, just as every medical man now is a public vaccinator.

The Qualifications of Meat Inspectors. Dr. Dittmar then proceeds to make some comments on the qualifications of meat inspectors, very truly remarking that the use of the public slaughterhouses depends upon the efficiency of their administration and more particularly upon the competence of the meat inspectors. The Royal Commission on Tuberculosis, 1895, recommended that no person should be allowed to act as meat inspector unless he had passed an examination before some authority

prescribed by the Local Government Board, or the Board of Agriculture, such examination to comprise the following subjects :

(*a*) The law of meat inspection, and such by-laws, regulations, &c., as may be in force at the time he presents himself for examination.

(*b*) The names and situations of the organs of the body.

(*c*) Signs of health and disease in animals destined for food, both when alive and after slaughter.

(*d*) The appearance and character of fresh meat, organs, fat and blood, and the conditions rendering them or preparations from them fit or unfit for human food.

Examinations for Meat Inspectors. The Local Government Board have recommended local authorities to satisfy themselves that the meat inspectors appointed possess the knowledge outlined. This is carried out in Glasgow, where the non-veterinary inspectors are examined by the corporation veterinary surgeon on the above lines. A similar examination is held by the Council of the Royal Sanitary Institute, and Dr. Dittmar remarks that it would be in the public interest if all applicants for the posts of meat inspectors or superintendents of a public slaughterhouse were required to submit evidence of having passed the examination of the Royal Sanitary Institute, or some equivalent examination in meat inspection. In our own opinion, the standard required in such an examination should certainly be regarded as the very *minimum* essential for any person who is appointed to act as meat inspector, and even that standard should only be accepted as a *temporary* one. We have nothing to urge against the examination itself, but as we have urged in other parts of this work, we are strongly of opinion that the meat inspector of the future should be one who has passed through a thorough training in theoretical and practical pathology and bacteriology, such as is given in the various veterinary colleges. In these institutions instruction in meat inspection forms part of the ordinary course of study or ought to do so. It is part of the work in the final year, and at the final examination students must pass in this subject.

The Edinburgh Course of Instruction in Meat Inspection. In the Royal (Dick) Veterinary College in Edinburgh great importance is attached to this subject. The course of instruction extends over two years, commencing in the third year of the students' curriculum. In that year the students attend a class held weekly at the slaughterhouse, in which all the organs in carcases which have been seized during the week, as being unfit for food, are demonstrated by the Professor of Pathology. This work is carried out in conjunction with the classes in pathology, of which it forms part of the practical work. In the final year the students attend a theoretical course of lectures on meat inspection and the various aspects of the meat industry, as well as attending a practical class at the slaughterhouse once a week. As a matter of fact, the instruction given in the Royal (Dick) Veterinary College has formed the basis of this present work, which is intended partly for those students. Experience has shown that this two years' training in meat inspection

is not one whit too much for the ground which has to be covered. It need hardly be said that in meat inspection, which is a subject of such great importance to the public health, there should be close co-operation between the meat inspectors and the medical officer of health for the district, whose opinion in the last resort, and in all cases which are not otherwise determined, must be taken as final.

Dr. Dittmar on a Uniform Standard. Dr. Dittmar then passes on to consider the question of a uniform standard of meat inspection for the health of the country, concerning which, in order to give full weight to his valuable opinion, we quote the following paragraphs :

" In regard to the suggestion that a uniform standard of meat inspection should be instituted that would be applicable over the whole country, the issue of a comprehensive code of procedure in connection with all possible conditions of disease or unsoundness in the animal body is, I think, impracticable. The best way to attain the object aimed at would be the universal institution of slaughterhouses under public control, and the staffing of these places by competent and thoroughly qualified officials. The issue of recommendations for guidance in certain specific and fairly well-defined conditions might, however, prove useful. This has already been done in the case of tuberculosis, which is the most frequent cause for the condemnation of the carcases of domestic animals.

" In respect of the action taken as the result of the discovery of tuberculosis in the carcases of animals slaughtered for human food in the public abattoirs of Scotland, there is, speaking generally, uniformity in regard to the condemnation of bovine carcases found so affected. The recommendations of the Royal Commission on Tuberculosis of 1898 are taken as a guide, and would appear to be fairly closely followed.

" But, in regard to the carcases of pigs found affected with tuberculosis, the administrative action of Glasgow is in marked contrast to that of other places. In Glasgow, doubtless owing largely to the more thorough and detailed inspection that is made of each carcase, more pigs are found affected with the disease than in other public abattoirs in Scotland. But, although between 4.23 and 6.68 per cent. of all pigs slaughtered in the Glasgow abattoirs from 1904 to 1906 were found affected with the disease, only about 2 carcases per 1000 were *wholly* condemned. Reliance is, in Glasgow, placed on the results of detailed examination of each carcase, and if the disease appears to be strictly localised, only the affected part is condemned, and the rest of the carcase is passed as fit for market. The Glasgow procedure is, I understand, modelled on that followed in Berlin, where localised tuberculosis in the pig is not followed by seizure of the whole carcase. The recommendations of the Royal Commission on Tuberculosis of 1898, in regard to the condemnation of pig carcases affected with tuberculosis, are not followed in the Glasgow abattoirs. It would be desirable both in the public and in the trader's interest if there were a greater degree of uniformity in the practice of different abattoirs in this connection. The present Royal Commission which is inquiring into the relation between human and animal tuberculosis may

be able to issue recommendations on the subject for the guidance of local authorities, on lines which will meet with universal acceptance."

The Necessity for Remodelling the System. We have, in other parts of this work, expressed our own views upon this important question, and would only repeat here that whatever difficulties there may be in the establishment of a uniform system and standard of meat inspection for the whole country, *those difficulties should be faced* and a really serious effort made to overcome them. No effort, which can by any stretch of imagination be so described, has yet been made, and it is not the slightest use attempting to produce such a system or standard by the appointment of one man here and there who has the necessary qualifications. *The whole system requires remodelling from the very beginning and a uniform standard of training in meat inspection first of all decided upon and demanded by law.*

This in itself would be an immense step towards the attainment of the ideal, because if all who are appointed to positions of meat inspection had been trained in the same way and to the same standard, it would be a comparatively simple matter, by means of common-sense regulations, to ensure that the same standard of health and disease was looked for universally. The present lack of system and of variation in standard is due to the fact that those who are acting as meat inspectors have not been trained upon the same lines, hence the inspection is more thorough, more scientific, or more haphazard as the case may be, in various places.

Dr. Dittmar's Opinion on Meat Inspection. Dr. Dittmar then has some useful remarks upon the subject of inspection of dead meat, by which we presume is meant carcases either whole or cut up which have left the slaughterhouse, or which have been imported into the city either from rural districts or other countries. As his opinion with regard to dealing with this meat is somewhat different to that which we have advocated in other parts of this book, we quote his words fully in order that they may have full weight.

"The inspection of dead meat can, under no circumstances, be fully satisfactory, as the internal organs in which are found the clearest evidences of disease are absent. Inspection by competent officers of all animals at the time and place of slaughter is what should be aimed at in this case also, and this will be attained by the increase of public and the abolition of private slaughterhouses. It is, however, in the public interest that as large a proportion as possible of the dead meat that comes into a town should be examined (whether this be of home or of foreign origin) before being placed on the market for sale as human food. For this purpose a central examination station to which all consignments could be taken would be of advantage in large centres of population. But if the submission of dead meat to examination at a central place or clearing-house were to result in the diminished use of public abattoirs, the institution of such places would be a distinct disadvantage to the public health, as it is only at the time and place of slaughter that a full and searching examination of the carcase can be made. Examination of

dead meat at a central examination station should not preclude future seizure in the course of shop inspection if this were found necessary; but if carcases that had passed examination were marked, it would facilitate shop examination, where inspection for evidence of disease cannot in all cases be satisfactory. But no marks either on meat or on the packages containing meat (such as are found in the case of some foreign and colonial consignments), to the effect that the particular specimen had at one time been examined and passed as fit for human food, should prevent re-examination or condemnation if this were considered necessary in the public interest. To obtain the full advantage of meat-marking, if this were instituted, it should be made obligatory in *all* public abattoirs.

"The enormous volume of the trade in dead meat of all kinds from the colonies and foreign countries should not be lost sight of in this connection. The desirability of subjecting this to expert examination before allowing it to be put on sale cannot be questioned, and the only place in which all of the consignments to a large town can be examined with any degree of thoroughness is some central examination station. The slaughterhouse or the dead-meat market might be used for this purpose, as is already done in the case of Dundee. In some places it might be necessary to provide special accommodation for this purpose.

"It might be possible to frame a regulation to this effect under the Public Health (Regulations as to Food) Act, 1907."

The Examination of Dead Meat. "It has already been pointed out that the examination of dead meat can, under no circumstances, be fully satisfactory, as the internal organs, in which evidence of disease is so largely found, are necessarily absent. The Government of this country should therefore be satisfied of the thoroughness of inspection at the time and place of slaughter and before meat is exported to this country. How this is to be done is not within the scope of this report; but, apart from minor considerations, two questions of fundamental importance are raised in connection with the provision of central examination stations, viz., first, the question as to the responsibility for selling or consigning diseased or unsound meat, and, secondly, the question as to what proportion of a carcase it should be permissible to import into this country.

"In Scotland, the person in whose premises unsound meat is seized and the original seller of the meat (or owner of the unsound or diseased animal from which the meat in question came) can be proceeded against, and, on conviction, fined. In other words, the responsibility for keeping or offering unsound or diseased meat for sale (whether this be of home or of foreign origin) rests on the trader. In the case of home meat, the original seller is also responsible. As a result of the exercise of these powers, the trade in diseased and unsound meat has been checked to a considerable extent.

"It has been suggested that clearing-houses or central examination stations should be instituted for the examination of all consignments of dead meat, whether of home or foreign origin. The responsibility for

the quality of the material, which at present rests on the trader, would, in this way, be transferred to the local authority. In support of the shifting of the onus of responsibility, it is said that the examination of meat is a subject for the specially trained expert, and that the ordinary man cannot be expected to have the requisite knowledge to enable him to come to a correct judgment as to the fitness or unfitness for human food of a particular animal or carcase. A little consideration will show that this reasoning is in the interests of a special class only, and not in that of the public generally.

"Although the trader cannot be expected to have the detailed knowledge of the scientifically trained expert, he can be expected to take reasonable precautions as to the wholesomeness for human food of the article he deals in. The removal of personal responsibility in this connection would not be in the public interest, and should, therefore, not be lightly contemplated."

Criticism of the Foregoing Opinion. It will be seen from the above that in Dr. Dittmar's opinion the responsibility for placing upon the market only good meat should not be transferred to the local authorities. Our own opinion is that it is one of the duties of the State to take in hand a thorough and efficient inspection of every carcase which has to be sold for human food, and that having done so, to so indicate the process to which the carcase has been subjected that the consumer or purchaser can tell at a glance whether he is getting that for which he is paying. There is no other way of doing this, as far as we are aware, except by stamping the meat with an official stamp when it is passed. That, of course, would not exonerate a meat-purveyor who sought to sell meat which had been kept so long after inspection or under such conditions that it had become unfit for food. But it would ensure that nothing except that which was judged to be good would find its way into the market in the first place. We agree that the establishment of any uniform system involves difficult points, but we do not admit for one moment that the difficulties are such as cannot be overcome by the exercise of a wise foresight and application of scientific knowledge. It has been found possible to do it in other countries, and there is no reason why it should not be done in Great Britain. As the law and the system stand at present it simply means that the owner of inferior qualities of beef, or doubtful or diseased animals, takes care that they are slaughtered in such places where they will escape any serious inspection.

As the result of this either the whole carcase or a part of it is smuggled into the towns and sold. This is an argument for the establishment of a central meat clearing-house in each city or district in which all meat, other than that which is killed locally, shall be examined before being allowed to be sold. This is the system which the present writer has seen working in Gothenberg with results which appear perfectly satisfactory.

CHAPTER IV

THE GENERAL PRINCIPLES UNDERLYING MEAT INSPECTION

WHATEVER the laws may be which govern meat inspection in nations or municipalities, and however definitely these regulations may be laid down for the help of the inspector, their application in practice will nevertheless ultimately always be a matter of common sense and an accurate knowledge of pathology. No regulations can cover all the problems upon which the modern scientific meat inspector has to decide at a moment's notice, and unless he has, in the first place, been thoroughly trained in comparative pathology, and is, in the second place, possessed of common sense, his inspection will at times be faulty. It is well, therefore, that before entering upon any detailed description and consideration of the special morbid conditions which comprise this part of our subject, that we should take a brief glance at the great general principles which should underlie all such work, and which alone can be taken as a safe guide by the inspector. It will also save much time and space inasmuch as we shall avoid the necessity of frequent repetition and similar advice. We may, therefore, take a rapid view of the various *kinds of diseases* with which the inspector meets and apply to these different types pathological knowledge and common sense.

General Derangements of Nutrition. Under this heading the pathologist recognises a number of morbid changes, all of which result from some interference with cell nutrition. The list of such conditions comprises: cloudy swelling, fatty degeneration, fatty infiltration, caseation, calcification, myxomatous degeneration, pigmentary changes, atrophy, hypertrophy, necrosis, and gangrene. All of these conditions have this feature in common, that they are produced as the result of some interference with cell activities. They are not specific diseases, although they may be found, and are found, accompanying many such. In themselves, however, they are local or general changes in tissues or organs which may be considered from that point of view.

The general principles, then, which should underlie the inspector's judgment in these morbid conditions is that he should take into consideration whether they are merely local manifestations restricted to an organ or area, and due to some cause acting only at that spot, or whether they are evidences of a more widespread general change, and therefore only part of the problem to be considered. For example, a liver in a condition of fatty degeneration may have been produced by the action on the cells of that organ of some toxic substance coming from the ali-

mentary tract and producing no other change. When fatty degeneration is seen in the liver in such a case, *the liver only* requires condemnation. The same condition, however, may be produced by some factor which is acting on the whole body; for instance, a deficient oxidation or a general poison, in which case not only the liver cells but many other tissues in the body will exhibit a similar condition. In such a case common sense demands that the judgment of the inspector shall depend upon the condition of *the whole carcase* and not of a part. Similarly, in the case of caseation, which is simply a special form of necrosis. This change may be simply a local one; for instance, the cheesy condition of the material sometimes found after there has been an abscess, in which case the locality in question is all that requires attention. On the other hand, it may be a local evidence of a very widespread condition of the whole body such as is associated with advanced stages of tuberculosis, especially in glands, to which condition indeed the term is usually applied. Here the judgment of the inspector is based not upon a local, but upon a general, examination. The above examples will suffice to illustrate our point, which is, that all these general derangements of nutrition will be approached by the inspector from two points of view, namely, *whether they are local in cause and result, or local results of a general cause.*

Disturbances of the Circulation. Under this heading come a number of conditions which are the result either of some mechanical interference with the course of the circulation of the blood, or are evidence of the reaction of the tissues to irritants. Mechanical interference of the circulation produces the conditions known by the following terms: active hyperæmia, passive hyperæmia (venous congestion), dropsy, œdema, &c., all of which are the result of an excess of blood in a part. Then there are the conditions known as ischæmia, hæmorrhage, thrombosis, embolism, infarction, &c., all of which, on the other hand, are due to a diminution in the amount of blood directly or indirectly. Both of these, however, depend upon mechanical interferences with the circulation either in the nature of dilation of blood-vessels, or contraction of blood-vessels, or pressure upon blood-vessels, or section of blood-vessels, or clotting in blood-vessels, or the blocking up of the lumen of blood-vessels with some substance. Once more the general principle is the same. The inspector must ask himself the question: Is this condition merely local and from a local cause, or is it evidence of a general interference with the circulation of the blood? If the former, then the situation affected only requires to be dealt with; if the latter, the condition of the whole carcase demands attention. Thus a venous congestion may be due simply to pressure upon a single venous trunk, in which case only the organ affected demands notice. It may, on the other hand, be a sign of heart disease or kidney disease, in which case the whole body will show evidences of congestion, dropsy, or œdema, and must be dealt with accordingly.

The second group of disturbances of the circulation, those which constitute the changes in tissues resulting from their reaction to irritants,

are the phenomena which we are accustomed to group together under the general term "inflammation." Once more the principle by which the inspector will be guided is that which enables him to form an opinion on the duration and variety of the particular inflammation in question. He will ask himself: Is this inflammatory reaction acute, subacute, or chronic? Is it superficial, or deep, or parenchymatous, or interstitial? Or, having regard to the quality of the exudate, he will ask: Is it serous, purulent, fibrinous, or hæmorrhagic? The answer to these questions will give him the clue to the formation of his judgment in any case.

Changes in the Nature of Repair. Another group of abnormal appearances are those which take place in an organ or a tissue as the result of the effort on the part of the tissue to repair some damage which has been done. The typical case in point is the production of a fibrous scar after the healing-up of a wound. As a matter of fact, most of the special tissues in the body, when destroyed locally, are unable to replace themselves, and their place is taken in time by a mass of fibrous or connective tissue. The due recognition of the nature of the process which has taken place will enable the inspector to deal with all such abnormal conditions in a common-sense manner.

Neoplasms or Tumours. In this category the pathologist places all those masses of tissue, usually newly formed, the growth of which is utterly irrespective of the needs of the organism. But he excludes from the list the products of inflammation, and the process of repair, as well as masses of tissue produced by the chronic infective granulomata. The general principle for guidance in dealing with tumours is the knowledge whether these are innocent or malignant; that the innocent ones affect only the locality in which they are found even though they be multiple; while on the other hand, the malignant tumours tend to produce general retrograde changes throughout the whole body, such as emaciation and wasting.

The inspector will therefore pay attention to the nature of the growth and use his judgment accordingly. The simple papilloma will thus be cut off from the body, which is thereby otherwise unaffected, while a malignant sarcoma or carcinoma will demand seizure of the whole carcase.

The same remarks may be made in reference to cysts, parasitic or otherwise, which are extremely common in the food animals. These will be dealt with according as to whether they are obviously local or part of a general parasitic infection of a dangerous character. In the former it will be sufficient to seize and condemn the organ alone in which the cyst or cysts occur, while in the latter case, for example, in those of trichinosis, the whole carcase will be withdrawn from sale.

Diseases of the Blood and Circulation. In this group of morbid conditions the pathologist places in the first place degeneration of blood-vessels, inflammation of blood-vessels, aneurisms, pericarditis, endocarditis, valvular lesions, and various forms of anæmia, leucocythæmia, together with hæmoglobinuria. Diseases of the arteries and veins themselves are not of great importance to the meat inspector, but some

conditions affecting the heart as well as some anæmic conditions are important.

These will be judged according as to whether they affect the general health of the animal, as to whether they are simple or septic, or as to whether they are merely local. Thus a pericarditis may be simply rheumatic, it may be traumatic, it may be simple, or it may be extremely septic. Common sense applied to pathological knowledge will determine what is to be done in each case.

The Chronic Infective Granulomata. This group includes that disease to which most of the meat inspector's time is devoted, namely, tuberculosis, and in addition glanders and actinomycosis. Here we are in the presence of diseases due to definite specific organisms which produce results occurring in these diseases alone, which therefore call for treatment *on their individual merits*. It is to be expected, therefore, that particular regulations will be laid down for the guidance of the meat inspector in such conditions, and this is actually the case. Those regulations are founded upon the common sense and expert knowledge of a large number of investigators and public officials, for the protection of the purchasers of meat.

The great general principle here—in common with all specific organismal diseases—is first of all to deal with such cases in relation to their infectiousness for human beings. That, indeed, is the basis of all judgments on bacterial conditions. It follows, therefore, that the meat inspector must keep himself thoroughly well informed and up to date in the advance of scientific knowledge in connection with these bacterial conditions. In cases where that knowledge has quite definitely settled the points under consideration, he will know exactly what to do. For example, knowing that anthrax in animals is communicable to man, in whom it produces only too often a fatal septicæmia, he will be prepared in all cases of suspicious and sudden deaths to satisfy himself that they were not due to anthrax before he allows the carcase to be opened. On the other hand, in a disease, such as tuberculosis, where the state of our knowledge regarding its infectivity to man *from meat* is not quite so definite, he will use his common sense and intelligence in endeavouring to conscientiously carry out the regulations drawn up from time to time by public authorities, which regulations in their turn change with the advance of scientific knowledge on the subject.

Bacterial Diseases in General. Apart from the special group of conditions just mentioned, there are a great many other bacterial diseases which come under the notice of the inspector and which in many cases present difficulties to his judgment, either on account of the uncertainty of the actual cause in any given case, or because of lack of definite knowledge as to the effect of such meat on the health of the public. Where the definite organism can be demonstrated, and where its effects on man are well established, the competent inspector will have no trouble. But in many of these cases the infection is either of a doubtful nature or of a mixed nature, and it is in these that the most careful consideration is

required. The general principles to be borne in mind will be that bacteria produce their effects either by their own multiplication, or by their power of production of toxic substances, or by a combination of both processes. The effects of these upon the carcase itself will be a guide as to the danger or otherwise of allowing it to be sold for food, but in addition it will also be remembered that *these toxic effects in man are sometimes produced in extreme degree from partaking of the food from animals whose meat did not show any marked alterations.* Only the inspector who has studied bacteriology can be expected to apply its general principles in a common-sense manner.

Parasitic Conditions. Various forms of parasites are far more common in the meat animals than the general public at all realises. Some of these parasites produce dangerous diseases when introduced into the human body, while others are perfectly innocuous to man. The inspector must therefore base his judgment upon the general principles of parasitology, and unless he is familiar with the knowledge of which parasites are dangerous and which are harmless, as well as with the life-histories of the different species, he will constantly find himself in difficult and doubtful positions. Thus, in the case of the parasite of trichinosis, which produces severe disease in human beings, he will have no hesitation in withholding the entire carcase from sale ; whereas in the case of the parasites which produce verminous pneumonic patches in sheep he will merely have the lungs destroyed, if badly affected, because they are not sound and healthy, not because of any danger of human infection. It will be necessary also for the inspector to be able to recognise with the naked eye appearances in the various internal organs which are produced by the invasion of them by various parasites. In such cases the parasite itself is frequently absent owing to its having died and degenerated. The evidence of this former presence, however, may be quite obvious in the shape of a thick bile-duct, a hard fibrous or gritty mass of tissue, or a yellowish caseated area, which is very frequently erroneously ascribed to tuberculosis.

In other cases large cysts may be found containing fluid, such as hydatids, and all these parasitic results demand for accurate judgment a knowledge of the general principles of parasitology.

Conclusion. It will thus be seen that we make a strong plea for a thorough scientific training in comparative pathology of all those into whose hands the important work of meat inspection is entrusted. There is not the slightest doubt at all that if the general public who are the consumers of the meat, and for whose benefit the meat industry exists, could be shown a series of carcases which had been seized and condemned as unfit for food, and could be given sufficient information as would enable them to judge of the prevalence of animal disease, they would insist in no uncertain manner that none but highly qualified men should be appointed to these duties, and that a proper system of meat inspection should be enforced throughout the whole country. It is one of those cases in which ignorance is far from bliss and in which it is supreme folly not to be wise.

PLATE XV

A TYPICAL FEVERED OR "FALLEN" UNBLED CARCASE

Note the varied dark colouring, due to the presence of blood, in various stages of decomposition; also the blebs or bullæ of gas.

CHAPTER V

MEAT AND ITS CHARACTERS

In the widest sense of the word, the term "meat" includes all those various parts of animals which are used for food, and therefore comprises such organs as the liver and others, irrespective of the actual tissue of which they are composed. In the present chapter, however, the term will be restricted to the strict signification of *muscle or flesh*, the other edible portions of the carcase being reserved for special description.

What is Meat? Meat, then, is the fleshy part of an animal, together with those other tissues which are intimately combined with it, such as the blood-vessels which ramify in its substance, the nerves which connect it with the nervous system, the connective tissue which surrounds and binds it together, and the minute quantity of fat which may be found between its constituent parts.

As an article of commerce, meat is always sold along with lymphatic glands and bones, to which the muscles are attached, in addition to the elements already mentioned.

The Structure of Meat. The intimate structure of meat must be known in order that the inspector may have an intelligent grasp of the changes to which this tissue is liable. Muscle is one of the most highly specialised tissues of the body; that is to say, it is a tissue which has been so modified in its development as to become capable of a very special function, namely, contractility. This specialised power renders muscle, in common with certain other body cells, much more liable to be affected by deleterious agents than are the less specialised tissues, such as those comprising skin and bone. Indeed it may be taken, as a general rule, that the more complex the function of any given tissue, and the more complicated the changes in that tissue, the more readily does it become diseased and altered, especially in the direction of various degenerations.

The essential elements of flesh or meat are the numerous striated fibres which make up its mass. These are tube-like structures tapering at each end, each fibre corresponding to a single cell and containing a nucleus.

The contents of such a cell are known as the sarcous elements, and the membrane which encloses them forming the wall of the muscle-fibre is the sarcolemma. It is in the sarcous elements of meat that the characteristic changes which follow upon death occur, changes which serve to differentiate muscle in both its physical and its chemical properties from any other tissue in the body. It is, of course, also in each sarcous elements

that the characteristic changes of muscle during life are developed, but with these we are not concerned. A number of muscle-fibres lying parallel to each other are bound together into bundles by a delicate network of connective tissue, and a number of these bundles in turn are bound into one large mass, which mass constitutes an anatomical muscle. This coarse structure of flesh can be partially observed by the naked eye after meat has been boiled, when it is more or less easy to separate out the constituent portions of the muscle. Amongst the fibres constituting any given muscle run the delicate veins and arteries and nerves and lymphatics, and these, too, when they reach a certain size may be observed in meat, the blood-vessels ramifying through the delicate connective tissue.

Colour of Meat. The colour of such meat or muscle or flesh in the ordinary food animals should be uniform, neither too pale nor too purple, but of a dark red tint, this appearance being caused by the red pigment of the blood itself, namely, the hæmoglobin. This fact being remembered, it will be at once obvious that any profound changes which occur in the blood, especially those in the direction of the disintegration of blood-corpuscles and their pigment, will at once be evident in the changed colour of the meat itself. Some meat, however, is not red but pale, muscles of this character being well developed amongst some animals, for example in rabbits and swine, and of course particularly well seen in fish. Further, the meat of calves is distinctly pale up to six months of age, and in older cattle the superficial muscles in the skin have pale portions. Boars, too, may show muscles destitute of red colouring. As regards their minute structure, the fibres composing pale muscles are more thin and more closely striated, but have the longitudinal striations less distinct than those of red muscle (Ranvier).

Muscular Contraction. The phenomenon of contractility may often be observed in muscles in an animal which has been freshly slaughtered, repeated twitching and contractions occurring. This, however, does not persist any length of time, for after a period of about a quarter of an hour in some cases, up to one of several hours in others, the meat becomes absolutely rigid. As long as muscles show the power of contraction the surface is of a glistening appearance.

Rigor mortis. A very important phenomenon following upon the death of living muscle is this rigidity just mentioned, which is technically known as *rigor mortis*. Much attention has been paid to this subject, especially from the medico-legal point of view, because of the importance of the symptom as an indication of the evidence of the time which has elapsed since death occurred. Unfortunately, the time of onset and the period of duration of *rigor mortis* are both liable to very considerable variation. The differences observed are due to an immense number of causes, amongst which may be noted the species of animal concerned, whether it be wild or tame, the presence or absence of certain medicinal agents within the system, and—of great importance—the nature of the disease from which the animal dies, in cases where death was due to

morbid process. The usual period of onset may be taken as varying from ten to fifteen minutes up to several hours, and the duration of the *rigor mortis* varies as much as from one to several days. The sooner this phenomenon appears the shorter the period of this duration, passing off, therefore, earliest in those animals in which it appears quickest. It is noticed first in the muscles of the head and neck, which become stiff. The process gradually extends through the entire muscular system until finally all are involved, at which time the joints cannot be moved. Coinciding with this rigidity is the disappearance of the glistening surface which was noted on the muscle previously. Instead of this glistening the tissue shows turbidity and opacity. The ultimate cause of the phenomenon of *rigor mortis* is the formation of lactic acid within the muscles, which coagulates the myosin. The presence of this substance gives to all edible muscle an acid reaction, which is hostile to the growth of bacteria, while, on the other hand, the decomposition of muscle, due to the action of bacteria, produces an alkaline reaction. Following the coagulation of the myosin, if a section be now made across the muscle a certain amount of serum appears on the surface which did not occur before.

After a certain number of hours have elapsed the muscles which became rigid once more grow soft, this further change being also attributed to a still further action of acids which now dissolve the myosin and render the muscle soft. As regards *rigor mortis* in fish, it is said to appear earliest and most intensely in the more vigorous and easily stimulated muscles (Ewart).

Rigor mortis and Decomposition. Decomposition in these tissues is observed to be closely connected in its period of onset with the disappearance of the rigidity of the muscles. It is also to be noted that *rigor mortis* persists for a longer time if the intestines be removed and disinfectants applied, and also in those carcases in which the brain and spinal cord are taken away.

Chemical Reaction of Muscle. The chemical reaction of muscle when living is neither markedly acid nor markedly alkaline, but owing to the formation of sarcolactic acid which takes place soon after slaughtering, the tissue then gives an acid reaction, this being capable of demonstration, as a rule, in a few hours in animals which are slaughtered. The acid reaction, however, may never appear, and the meat commence to undergo decomposition without giving an acid reaction. The organisms of putrefaction, owing to their power of producing ammonia, render the reaction alkaline.

Tenderness of Meat. From the point of view of the consumer, the most important qualities of the meat, in addition to its palatability, are its toughness or tenderness ; and it is well to bear in mind the conditions necessary in order that meat when cooked shall be sufficiently tender. These conditions are partly structural and partly connected with the length of time which has elapsed since death. Tenderness in meat seems to depend largely (as far as structure is concerned) upon the amount

of connective tissue present being small in quantity and delicate, and the presence of a thin cell membrane together with short muscular fibres. Further, there should be allowed sufficient time for the natural disappearance of the condition of the *rigor mortis* before cooking is begun.

Variation in Toughness in Raw Meat. According to Leahmann the variation in the toughness of raw meat depends upon the amount of collagen contained. Tissue containing this loses all its firmness during cooking, and meat, therefore, which is rich in delicate connective tissue becomes much softer when cooked, while meat which has but little connective tissue is comparatively little changed.

Effect of Hanging Meat. The same investigator states that, owing to acid fermentation, meat loses about one-fourth of this toughness if it be hung for a few days. The most palatable of all meat, perhaps, is that which is allowed to remain in cold storage for from two to three weeks ; such meat, being exposed for this length of time to the gradual action of the acids within, becomes unusually friable and thus extremely tender.

Tender Portions of Carcase. Apart altogether, however, from the question of time which the meat has been kept and its method of storage, there remains the further consideration as regards tenderness of the special part of the carcase from which the meat is obtained, since all the flesh is not equal in this matter. It may be laid down, as a general rule, that those muscles of the body which are least used in violent muscular exercise, as well as those which are the least exposed, supply the tenderest meat. This is simply because the more violent the exercise taken, the thicker becomes the cell-wall of the muscle, and the more dense the connective tissue holding the fibres together. At the same time, it will be remarked that the more a muscle is used the greater will be the blood-supply required for that muscle, and hence it is that one often finds tough cuts of meat more juicy than others. Further, the meat which is in immediate anatomical connection with joints contains a large quantity of connective tissue, and is therefore tough, and so it is often said that meat increases in tenderness the further it is from either the head or the rump. The cuts of meat taken from the loin and the prime ribs are everywhere regarded, therefore, as the best.

Turning next to the more important general characters which differentiate the meat from the various food animals from each other, as well as animals of different ages and sexes in the same species from each other, we may notice the following points.

The Carcase in Cattle. A healthy carcase in good condition of fattening will be very well covered with fat on the surface, and the meat will show considerable marbling of fat running throughout it, the fat itself being of a creamy whiteness unless the animal has been entirely fed upon pasture or other foods which may impart to the fat a yellow tinge. The colour of the beef itself varies somewhat according to the age of the animal, as well as with the sex, and when fresh has a faint odour of a somewhat sweetish character peculiar to itself. The meat is firm and ought not to exhibit any undue amount of moisture. Frozen meat,

which has been thawed, may be very wet upon the surface, a condition which is not to be mistaken for the serous exudate associated with dropsical or other diseases. In young cattle from six to fifteen months old the meat is light red, containing but little fat, and is of a firm, elastic consistence. Bulls from one to four years of age (beyond which time they are not usually retained) possess meat which is poor in fat, coarse in the grain, tough in consistency and dark red in colour. The meat of steers from one to six years of age is light red in colour, strongly marbled with fat, firm in consistence, assuming a brick-red tint after being hung. In older oxen, especially in those which have been used for purposes of traction and fattened for slaughter, the meat is tougher, more firm and darker in colour, possessing but little fat except that under the skin and in the omentum, mesentery, and associated with the kidney. The meat of fat heifers, as well as of young cows, is practically similar to that of steers. In older milch cows, however, the adipose tissue is not commonly so abundant and the meat firmer in quality.

The Carcase of Calves. The meat of calves, which is known as veal, is light or pale red in colour, finely grained, but inclined to toughness rather than tenderness. If the carcase has been fattened upon milk (particularly as long as it is being fed upon milk) the meat is whitish, sometimes almost pure white, the consistency varying according to the age of the calf together with the amount of fat present. In new-born calves the meat is always of a watery consistence and is known as "slink veal," this meat soon becoming acid when kept. The odour of calf meat differs from that of full-grown beef, being sometimes described as an acid smell, especially marked after keeping. In calves killed during the first week of life—a period which we shall discuss in connection with maturity, and during which the meat ought not to be exposed for sale—the meat is paler in colour, soft in consistence, and contains a large amount of water. In order to test the consistence of the muscles the finger may be firmly pushed into the hind quarters, when it will be found quite easy to penetrate them. Whatever fat is present is gelatinous.

The Carcase in Sheep. Mutton is light red, or even brick-red, in colour, moderately firm in consistence, fine-grained in the fibre, having white, hard, clear, and abundant fat existing between the muscles, as well as being plentiful under the skin and round the kidneys.

In older sheep which are relatively poor, the mutton shows both less fat and less meat in proportion to the amount of bone, the meat itself being darker red in colour and firm in consistence. The odour of mutton is peculiar to itself, sometimes reminding one of the smell of the rumen, sometimes being of the smell of the sheep itself. The normal fat of sheep is always white, and the meat of the old ewes is of an inferior quality, being usually lean and dry. Lamb from the young sheep, though not so firm as mutton, is still fairly firm in consistence, but the fat is softer.

The Carcase in Swine. Of all flesh-foods pork is the least firm in consistence. It is pale red or pink in colour, some of the muscles being white. The fat should be white and clear, abundant in quantity, surrounding

the muscles and infiltrating them. The fibres of the meat are fine, the consistence soft and the odour not well marked. In old breeding animals (both boars and sows) the pork is firm in consistence, dark in colour, poorer in fat, and there may be a strong odour of urine, extremely disagreeable either when the meat is fresh or during cooking. In such old breeding animals there may be extremely little adipose tissue under the skin, together with a hardening of the skin and subcutaneous tissue over the thorax, producing what is termed the "shield."

Colour-change from Cooking Meat. It may be here mentioned, as being worthy of note, that the process of cooking causes almost all meat to become grey in colour, with the single exception of pork, which becomes white. The change of colour is due to the breaking up of the pigments in the blood, a process which takes place at a temperature of from 60° to 70° Cent.

Judgment of Age and Sex. The qualified veterinary meat inspector will find no difficulty in estimating the age of any given animal during life, the condition of the teeth being his best guide ; but in the case of slaughtered animals the problem becomes very much more difficult because the head may not be present in the specimen under examination. Nevertheless, it is necessary that there should be some means of determining the age and sex of carcases, because these may be necessary with regard to evidence brought forward in connection with cases of insurance, and perhaps still more important in their bearing upon the relationship between age and sex and the presence or absence of certain diseases.

As far as the age of calves is concerned, we have enumerated the most important points in the section dealing with immaturity. The following table indicates the changes which take place in the dentition of cattle, from which the age may be estimated if the teeth are available.

Bovine Dentition as a Means of Estimating Age. As in other animals the age of the animal can only be estimated with certainty by an accurate knowledge of the times of appearance of the temporary and permanent teeth, and we therefore append several tables showing the dates at which, on an average, the teeth appear and change. The tables are compiled from slightly different points of view, and in one or other of them will be found the information required on this matter.

BOVINE DENTITION

Age	Teeth
1 month	Incisors (temporary). All present.
6 months	Fourth molar teeth. This is persistent during life.
Yearling	Fifth molar, newly up, demonstrated by its new appearance. Table of tooth unworn. Depressions well marked, &c.
1 year 9 months	Central permanent incisors replace the temporary ones.

Age.	Teeth.
2 years . . .	Has well-developed central permanent incisors, "nipping teeth." Also sixth molar present at this age.
$2\frac{1}{2}$ years . . .	Middle pair of permanent incisors are cut.
2 years 9 months . .	Lateral pair of permanent incisors well up. If worn equal to the middle pair, say, three-year-old.
3 years . . .	All cheek-teeth (six) are present.
$3\frac{1}{4}$ years . . .	Age for cutting last pair of permanent or "corner incisors." Varies a little.
4 years . . .	"Corner incisors" show wear, but not nearly so much as other incisors. Less evident when soft foods have been given.

Table showing how Bovine Ages can be told by Teeth

Teeth.	Eruption.	Change from Milk to Permanent.
Incisors:		
Central .	At birth or within one month	$1\frac{1}{4}$ years
Middle .		$2\frac{1}{6}$–$2\frac{1}{2}$ years
Lateral .		$2\frac{1}{2}$–3 ,,
Corner teeth		$2\frac{5}{6}$–$3\frac{1}{2}$,,
Cheek-teeth:		
First ..	At birth ..	$2\frac{1}{4}$ years
Second ..	,, ..	$2\frac{1}{4}$,,
Third ..	,, ..	$2\frac{1}{2}$,,
Fourth ..	6 months ..	Persistent
Fifth ..	1 year ..	,,
Sixth ..	$1\frac{3}{4}$ years ..	,,

Table of Bovine Dentition

	Incisors.			Corners.	Molars.					
					Premolars.			Molars.		
	Central.	1st Latl.	2nd Latl.		1	2	3	4	5	6
Bovine Dentition Milk .	Birth.	Birth.	Birth.	2–3 weeks.	2–3 weeks	Birth.		—	—	—
Permanent	18–21 months.	2–$2\frac{1}{2}$ years.	3 yrs. 3 months	$3\frac{1}{2}$–4 years.	2 yrs. 3 mths –3 yrs.	$1\frac{1}{2}$–2 yrs. 9 mths	3 yrs. to $3\frac{3}{4}$ yrs.	6–9 mths.	$1\frac{1}{2}$–$2\frac{1}{2}$ yrs.	$3\frac{1}{2}$–4 yrs.

Summary and Recapitulation of Bovine Dentition

The Molar Teeth

(1) An ox has twelve temporary cheek-teeth.

(2) These are first, second, third; whereas the fourth, fifth, sixth are permanent cheek-teeth.

(3) The fourth cheek-tooth is present at six months.

(4) The fifth cheek-tooth is present at one year.

(5) The sixth cheek-tooth is recently cut at two years.

(6) The first, second, and third cheek-teeth are shed and replaced by permanent teeth between two years and three months and three years.

The Incisor Teeth

(1) Shedding of milk incisors and replacing by permanent teeth takes place between one and a half and three and a half years.

(2) The presence of a central pair of broad permanent incisors indicates that the animal is eighteen months; if these are worn at the edges it indicates two years.

(3) From three to nine months later the middle pair of incisors are present, the average age being two and a half years.

(4) Lateral permanent incisors are cut about three years of age. (Sometimes the corner teeth are cut at this age.)

Corner Teeth

Permanent corner teeth are present on an average at three and a quarter years old.

Subsequent Changes

These are confined to the wearing surfaces, the teeth becoming shorter, smaller and wider apart. Old age may be conjectured from the appearance of wear.

Joints and Age. In addition to the teeth, other parts of the body furnish certain evidence relative to age; thus the younger the animals the more cartilage is there in connection with the joints, and also the more porous and vascular are the bones. These characteristics are well seen in the vertebræ as well as in the pelvic bone.

Estimating Age. A rough way of estimating the age of cows is by counting the number of rings on the horns and adding two to the number present, the result giving the number of years old of the animal. The method, however, is not reliable, inasmuch as the rings are only formed regularly when the animals have been pregnant, and not without variation even then. More reliable evidence is furnished by the skeleton itself. Thus the pads of cartilage at the growing ends of the bones disappear when the bone has reached its full maturity. Further, the articular cartilages themselves on the surface of joints become ossified as the animal gets older. A most useful point in the estimation of age is the

condition of the ischio-pubic symphysis, which is always divided when the animal is slaughtered. If careful note is taken of the process of ossification in connection with this joint, valuable information is gained. The division of the joint can be readily made in a young animal *with the knife*, while in later years, when the cartilage is replaced by bone, it requires either the *axe* or the *saw* for its division. The cartilages of the sternum become ossified in the middle line in the second year of life. Further, those cartilages which are associated with the ribs, the trachea, the scapula, and the spinous processes, all become ossified as time goes on. Thus all the spinous processes become completely ossified with the

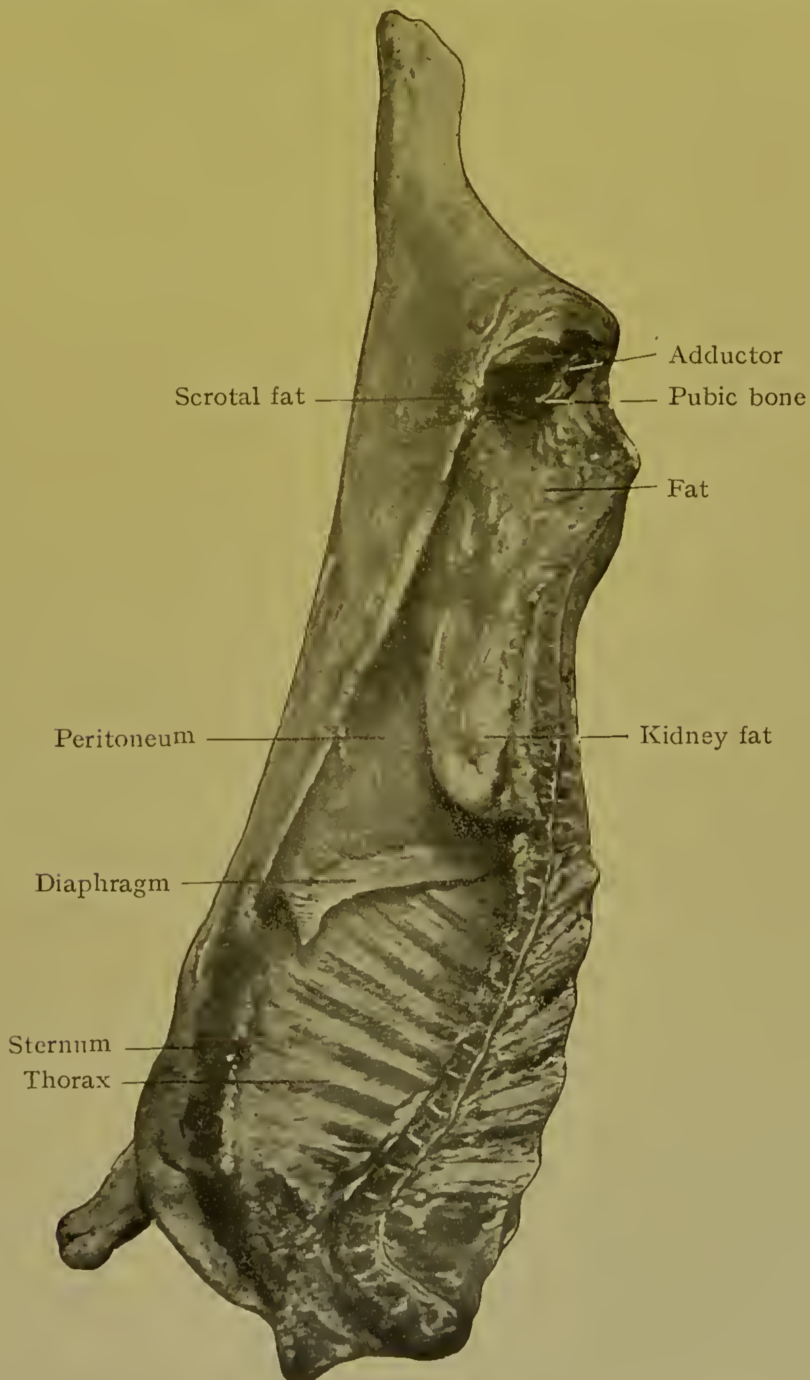


Fig. 1.—Half of Ox Carcase

first year of life. Up to the end of that year these cartilages are quite distinct from the bones, and during the second and third years of life they are found to contain within them increasing areas of bony matter, the white colour of the cartilage showing the transition to the greyish red of bone. The long tubular bones also furnish some information. Their medullary cavity gradually increases after birth and contains more and more marrow of a fatty character, this being replaced in old animals by a serous gelatinous material.

DETERMINATION OF THE SEX

It is frequently a matter of considerable importance that the meat inspector should be able to specify the sex of any carcase under notice, and the following points to which Ostertag draws attention may well be noted in this connection.

Cattle. The carcase of a bull may be recognised by the extremely massive development of the muscles generally, and particularly those in the region of the neck and the shoulder, as well as by the dark colour of the meat itself and the small amount of fat present. The inguinal canal also is open in the carcase of a bull. In the ox the muscles of the shoulder and neck are less prominent and the inguinal ring is hidden by the scrotal fat. In the case of cows, it must be remembered that the udder is usually removed except for a small portion in the posterior part. A certain amount, however, of the gland tissue may remain, and underneath this will be found the supramammary glands. A very characteristic point is the shape of a cross-section of the adductor muscles of the thigh. This section in male cattle is triangular, whilst in females it is more rounded or bean-shaped. The two skeletons also, especially as regards the appearances on section of the pelvis, show well-marked differences. Should it be required to decide as to the sex of any given skin which has been separated from the carcase, the most reliable features are those connected with the horns, which in the bull are straight, short, and conical. In the ox they are curved, longer, and strong ; while in the cow they are also curved, shorter, and more slender.

The distinction between the sexes in the case of sheep and swine presents little difficulty owing to the way in which these carcases are dressed.

Summary of Characters for Differentiating Carcases. It will be of assistance to the meat inspector if we here summarise in tabular form the various anatomical characters of the sexes in cattle, sheep, and swine ; drawing attention to some points not usually mentioned in this connection.

SUMMARY OF DIFFERENTIATION OF THE SEXES IN DRESSED CARCASES

CATTLE

BULL.	BULLOCK OR STEER.	COW.	HEIFER.
Hind-quarters Bones of hock large, round.	Bones well developed but not so large as bull.	Bones comparatively small and light.	Same as cow.
Flesh extends close to hock joints.	Not so close to hocks.		

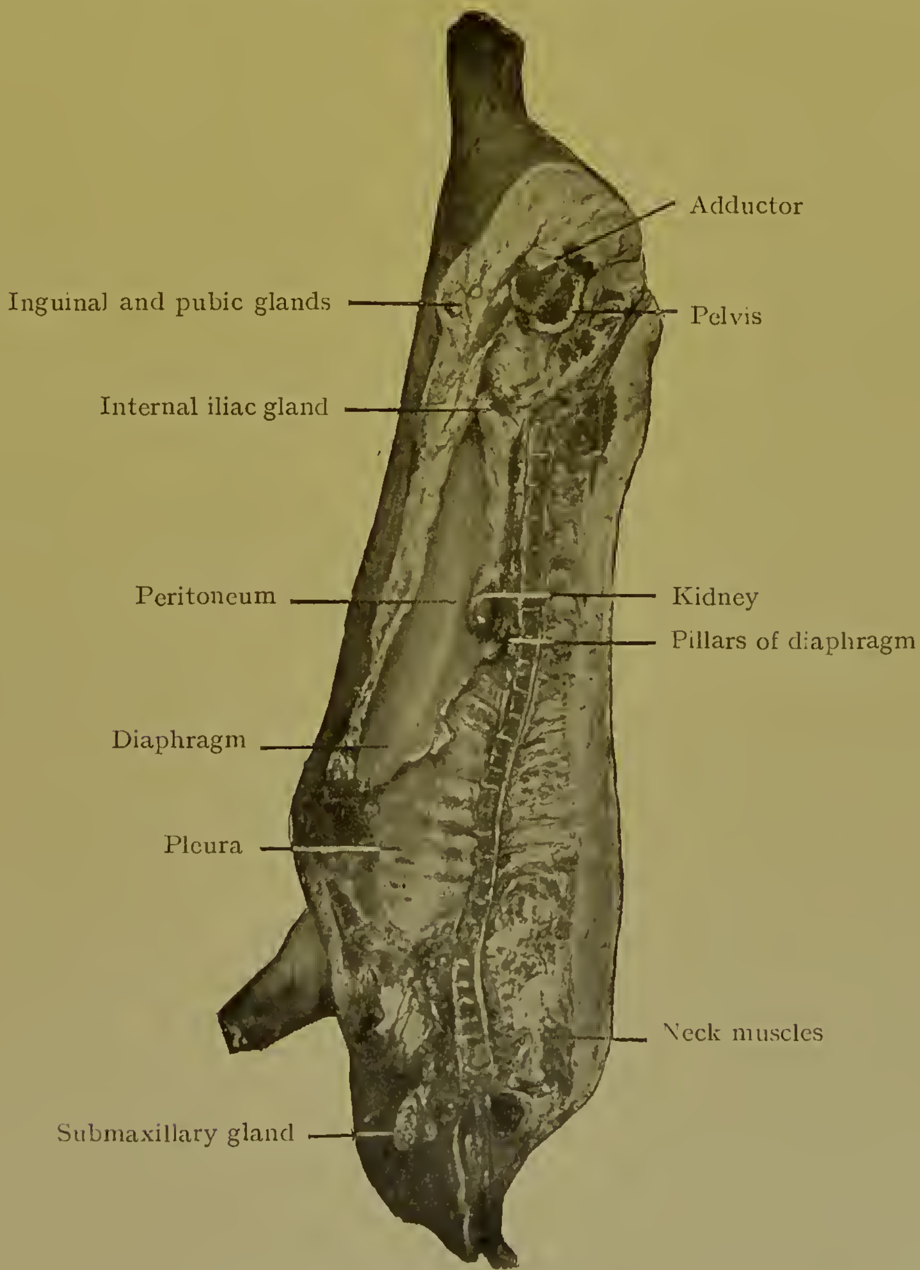


FIG. 2.—HALF OF DIVIDED PIG

CATTLE—*continued*

BULL.	BULLOCK OR STEER.	COW.	HEIFER.
Thigh musculature highly developed.	Thighs well developed but not so round as in bull.	Muscles weakly developed, giving the posterior line of the thigh a concave shape.	In fat heifers the muscles may be well developed, resembling more the bullock than the cow.
Cut surfaces of the gracilis muscles, the "gyps" somewhat triangular.	The "gyps" more markedly triangular, being completely covered with fat down to the middle of the ischio-pubic symphysis.	The gracilis muscle free of adipose tissue, giving the "gyps" a semicircular shape, with the whole length of the ischio-pubic symphysis as the diameter.	Same as cow.
Tuberosities of the ischio-pubic symphysis large, giving the bone an angular shape.	Tuberosities not so large, and bone not so angular.	Tuberosities not well marked, section of bone thinner and straighter.	Same as cow.
No great deposit of scrotal fat, which is ragged and irregular.	Large deposit of scrotal fat, more compact and regular.	Udder usually removed, leaving line of section evident on abdominal wall.	Udder small and fatty, left *in situ*.
External inguinal canal open.	External inguinal canal closed.	Parts of mammary gland usually visible.	Mammary glands not exposed.
Penis usually removed, leaving groove down the edge of abdominal section.	Penis left *in situ*.		
Erector and retractor penis muscles well developed.	These muscles weakly developed.		

A "segg" is an animal which has been castrated only a short time prior to slaughter. The hind-quarters resemble those of a bull, but there may be more fat. The scrotal fat may be compact and regular like a bullock, but the inguinal canal remains open.

Abdominal Cavity Kidney-fat may be largely deposited, but usually not so much as in bullock.	Large deposit of kidney-fat, as well as general abdominal adipose tissue.	Kidney and abdominal fat scanty, except in very fat young cows.	Usually fattened and fairly large deposit of fat.
Thoracic Cavity Vertebræ strong and heavy. Ribs also strongly developed and markedly curved outwards or backwards as the carcase hangs. Otherwise resembling those of bullock.	Vertebræ not so heavy. Ribs arched lengthwise in backward direction, narrow, with wide intercostal space.	Vertebræ lighter in weight. Ribs not so arched, giving the whole chest-wall a flatter appearance. Ribs wide with narrow intercostal space.	Same as cow.

CATTLE—*continued*

BULL.	BULLOCK OR STEER.	COW.	HEIFER.
Fore-quarters Bones heavy and musculature well developed, especially neck and shoulder. "Crest" well marked.* Little superficial fat, allowing muscles to be more visible.	Weaker development of neck and shoulder with considerable deposit of superficial and inter-muscular fat, covering the musculature from view.	Much lighter development of bone and muscle. Usually less fat than bullock. "Napoleon's head" formed by the paniculus carnosus distinctly visible on back.	Same as cow. In fat heifers this is not so well marked.
Flesh Coarse grained and dark in colour, with little or no intra-muscular fat.	Muscle-fibres finer. Bright florid hue, with admixture of intramuscular fat.	Fibres very fine, giving the meat a softer appearance and feel, but darker in colour, especially in old cows. Usually no intramuscular fat.	Fine grained, somewhat soft flesh but bright colour, and in fat heifers intermingled with fat.

SHEEP

RAM.	WETHER.	EWE.
Strongly developed gigots, loins, and neck.	Gigots, loins, and neck somewhat lighter.	"Chumps," *i.e.*, across the sacral region, wider, loins narrower and thinner.
Neck short and strongly developed.	Same as ram, but not quite so thick.	Neck, longer and thinner.
Adipose tissue may have a slightly yellowish tint.	Fat usually pure white.	Fat white.
Flesh coarse and dark in colour.	Flesh finer and slightly slaty-red colour.	Same as wether.
Immediately after slaughter, odour is distinctive and characteristic of ram.	Odour not so distinctive.	Odour slightly "woolly."
Penis usually removed.	Penis left on inner aspect of abdominal wall.	Udder left in position except in old ewes, when it is removed, leaving the lines of separation evident.
Little or no scrotal fat.	Slight deposit of scrotal fat.	
	Ischio-pubic symphysis can be divided with knife.	Ischio-pubic symphysis is harder and has to be cut with saw.

* The ligamentum nuchæ of the bull is sometimes divided close to the dorsal vertebræ, allowing the neck to extend, and thus reducing the prominence of the "breast," giving the neck the shape and appearance of that of the bullock.

PIGS

BOAR.	HOG.	SOW.
Carcase usually split, showing bones and flesh dark red.	Penis and sheath are removed, giving the line of the abdominal wall a slight curve.	Line of abdominal section straight.
The head is easily recognised.		
Teats are present but they are comparatively small and blind.	Teats small and blind.	Teats larger with duct more visible. In older sows the teats are frequently cut off.
	Flesh light in colour.	Flesh light in colour.

VARIOUS BEEF POINTS

If young and freshly killed, the meat should be ingrained with streaks, dots, and pieces of suet throughout it.

If the animal is healthy and cool when killed, the suet will be very firm, white, dry, and crumbly. The lean or ox beef will be a dark red when first cut, changing to a bright or cherry colour on exposure to the air, due probably to its juices coming to the surface. It should be juicy, firm, and somewhat elastic, smoothly grained and velvety to the touch.

Heifer beef is more closely grained and perhaps less bright in colour, the bones smaller and the suet a purer white. The meat of a lean animal is inferior. If the fat is yellow, oily, or fibrous, it is not prime beef. Too much fat is wasteful in trimming. Bull beef is the coarsest and most rank in flavour. It is known by its darker colour, close, tough fibre, and the bad odour of the fat. A bluish colour denotes poor beef. A pale, moist muscle indicates a young animal, a deeper hue an older one. The age for prime beef is from three to six years old. A steer will average 800 lb., a heifer 500. Twenty per cent. of the animal can be counted as bone. Beef is best during the winter and spring, after being grain or stall fed. Grass-fed beef may be juicy and tender, but it lacks the flavour of grain beef and is less solid. Grain- or stall-fed beef shrinks less in cooking than grass-fattened animals. The latter are seldom salted down.

Work oxen, when fattened, make better beef than the steer that has always been fat. The meat on those parts of the animal where the muscles are least called into action are the most tender and succulent. Beef should be kept some time before it is cooked to allow it to ripen. A month in the winter time will greatly improve it, and as long a time as is possible in the summer, if kept in a "cooler" or in cold storage, where an even temperature can be maintained. If meats are beginning to spoil, this can readily be detected by thrusting a knife into the bone, a decided odour being on the knife-blade. Meats that have been frozen may lose some of their flavour, though they become more tender. Cooling-

rooms should be built to avoid freezing or bringing the meat in contact with the ice, and should aim to keep at as high and dry a temperature as is possible. Freezing meat hastens decomposition after it sets in. Fresh beef shrinks about one-fifth in cooking. Food-preservative (dry antiseptic) will preserve cut pieces a long time. The hind-quarters have more meat in proportion to the bone, and should bring a much better price, though some claim that the meat from the fore-quarters is more juicy and delicate in flavour. The best steaks are cut from the middle of the rump, and may weigh as much as 4 lb. when properly cut with the bone and fat (trimming somewhat reduces this).

A good steak should be cut one inch thick from a piece of beef that has been kept at least ten days in a cooling-room, and should never be pounded. The orthodox Hebrews never eat the hind-quarters of an animal, as it is forbidden them by their religion. The ribs, sirloin, and rump are the best pieces for roasting. The round, buttock, edge-bone, shin, brisket, shoulder, and clod are all excellent stewing and boiling pieces.

To prevent meats that flies have touched from spoiling, rub with a little vinegar, drying immediately afterwards.

Characteristics of Good Meat. The following general description of the characteristics of good meat is by Dr. Hope, Medical Officer of Health of Liverpool, and should therefore appeal to many of those occupying similar positions. "In all cases the carcase should be that of a well-nourished animal, without signs of attenuation or wasting; the pleura and peritoneum should be free from adhesions or staining. Good meat is firm and elastic to the touch, without œdema or emphysema, not pitting nor crackling on pressure; it should be juicy, but not wet nor flabby; the colour should be uniform, without brown or discoloured patches. Good beef is of a bright red colour, marbled with fat; veal is always paler and less firm to the touch; mutton is dullish red, firm, the fat hard and usually white; in both beef and mutton a uniform yellowness of the carcase, almost a saffron tint, may be associated with perfectly healthy conditions. The carcase of the pig should be plump; the flesh is naturally pale and the fat somewhat soft; the skin should not set in folds or wrinkles, and should be without stains or blotches; bruises and scratches are not uncommon. In all cases when sufficient time has elapsed for the carcase to cool and set, the fat should be firm and the suet hard, containing no watery jelly or juice, free from blood-stains, and creamy white to yellowish in colour. Particular attention should always be paid to the connective tissue about the flanks, shoulders, and diaphragm and region of the kidneys; signs of wetness, œdema, imperfect setting or diseased glands should be absent; the thoracic and abdominal parietes should be without signs of old adhesions, staining, or evidence that anything has been stripped away, which is sometimes done to remove signs of inflammatory disease. The odour should be sweet and agreeable; a skewer thrust deeply into the flesh should have no unpleasant odour when withdrawn. Bull beef, it must be remem-

bered, is usually dark, but in other cases abnormal darkness of the flesh is to be regarded as suspicious of imperfect bleeding. Every few seconds which the blood remains in the carcase after death is a matter of consequence. In the case of cattle, the animal, immediately it is knocked down, should be bled" ("Encyclopædia Medica," Food).

Characteristics of Unsoundness. The same authority thus describes unsound meat: "In *chronic* disease the carcase is usually more or less emaciated, sometimes to an extreme degree. The flesh of diseased animals is pallid in appearance and, together with the connective tissue, may be infiltrated with serum; the fat and visceral connective tissue are also wet and flabby, and the fat will not set; occasionally the pleura is found to have been stripped off from the ribs to remove evidence of pulmonary disease. In *acute* inflammatory diseases the affected organ will present the ordinary signs of inflammation, but if the animal be slaughtered at an early stage of the disease, and is properly bled and dressed, the flesh is usually normal and sound; if, however, the animal has not been killed until nearly moribund, or if the disease has made progress, the carcase will be found to be red and congested from imperfect bleeding; it does not set properly, the flesh is dark, dry, and sticky, and frequently giving off an unwholesome odour of drugs, which can best be detected by plunging a skewer deeply into the flesh and noting the smell upon withdrawal."

THE FAT OF DIFFERENT FOOD ANIMALS

The adipose tissue in the different species of food animals presents characteristics in the direction of colour, consistency, composition, and melting-points which enable the meat inspector to differentiate the fat of one animal from that of another. Speaking generally, the normal characteristic of fat is that it is opaque, white or yellowish white in colour, containing a very little blood (if any) and varying according to the surrounding temperature in its melting-point. A cross-section of fat exhibits under the microscope an acinous structure. As regards the melting-point, it should be said at once that the adipose tissue from both sheep and cattle sets hard even during the heat of summer. The actual consistence of any given fat depends upon the amount of stearin and olein contained; the greater the amount of stearin present the firmer the consistency of fat and the higher its melting-point. The greater the amount of olein present the softer the fat. This normal consistency varies in the case of various domestic animals, but is also influenced to a certain extent by the constituents of the food-supply, so that any percentage composition stated must be regarded as only relatively accurate and referring, probably, only to an animal fed upon a special diet. The influence of food on the production of fat is, of course, immense. Thus the process of fattening is accordingly assisted by a liberal protein diet to which fats and carbo-hydrates are added in proper proportions. The method of feeding also exerts some influence, although there are certain

special breeds (especially in pigs) which seem to be very little susceptible to special methods of feeding. Cattle which have been fattened upon pastures alone may exhibit a yellowish colour in the fat known as "yellow feed-colouring." A generous diet of maize also produces a slight coloration in fat in swine, in which animals the firmness of the fat varies considerably according to the quality of the food given.

What Danish Experiments show. Danish experiments indicate that the best bacon is produced from a diet composed of milk, potatoes, and barley, the result being a very palatable article which is firm, well marbled, and thick. The same experiments, however, show that after swine attain 120 lb. in weight, fattening on maize should be discontinued, in order to avoid a softness in the bacon which otherwise results. Oats are said to produce a somewhat oily taste in the bacon, while the result of fattening on beans gives the same substance but a slight bitterness. Bacon raised almost exclusively on swill exhibits qualities which are not at all agreeable, the bacon being soft, oily, and insipid, probably from the quantity of rancid fat contained in this food. All experimenters agree that the injurious effects upon the quality of the fat produced are due to some particular kind of fat in the food-supply.

Characters of Fat in Various Animals. The following are the principal characteristics of the fat of special animals.

Cattle. In young fattened prime animals the adipose tissue is white and exhibits a firm consistency after setting, which it does very rapidly, becoming quite solid at the ordinary atmospheric temperatures. Bovine fat is said to contain about one part of liquid to three parts of solid fat, melting at a temperature from 41° to 50° Cent. In young cattle which have been grass-fed and fattened the adipose tissue is yellow, a colouring which might also be found to be present in old cows, in which animals the fat is found to be relatively softer than in younger ones. In calves the fat (which is found at first only in the region of the kidneys) is at first of the pale greyish red colour. Pure white fat is found in the region of the kidney in calves when they arrive at the age of from four to six weeks, and it is stated that when from five to six months old the fat in calves disappears again.

Young calf fat is reddish white at first, becoming white later, and is of a considerable less consistence than that in full-grown cattle.

Sheep. In sheep the adipose tissue is of a particularly pure whiteness without any smell, and melting at from 31° to 52° Cent., the same qualities being present as in the adipose tissue of the cow.

Swine. Normally the adipose tissue is white, any departure from this colour being due to special fattening. Thus it becomes yellowish after feeding upon corn, and greyish if fish have played an important part in the dietary.

As we have already stated, this consistency varies considerably with the food and the breed of the pig. We need only consider the case of pure-bred British swine, in which the consistence of the fat is firm, melting between 40° and 50° Cent.

CHAPTER VI

POORNESS, EMACIATION, EMERGENCY SLAUGHTER, AND NATURAL DEATHS

THE judgment of the inspector in dealing with the carcases of animals which exhibit the conditions known as *poorness* and *emaciation* is a question which occasionally causes some considerable difficulty, inasmuch as there is no hard and fast line of demarcation between carcases of this nature which may be regarded as fit or unfit for human food, at any rate so far as poorness is concerned. Neither is there any uniform standard adopted in the various centres of the meat industry. What is unhesitatingly condemned in some slaughterhouses is just as readily passed in others, and so it becomes a question of the personal opinion of the individual inspector as to what carcases do or do not reach the standard which he himself requires in order that they may be sold for food. This being the case, all that is possible for us here is to state the causes and signs of these conditions in animals, together with those considerations which, in our opinion, should lead the inspector to form a correct and fair judgment of such carcases.

Distinction between Poorness and Emaciation. In the first place, it must be clearly recognised that poorness and emaciation are two absolute distinct conditions, although the words are constantly used synonymously by inspectors. As a matter of fact, the condition of the carcase in both cases may exhibit very much in common, but it is of vital importance in coming to a judgment of such carcases that the inspector should distinguish in his mind very carefully whether he is dealing with a poor or emaciated carcase in the strict sense of those words. The distinction between the two is one of origin. It depends upon what has caused the poorness, or what has produced the emaciation.

Poorness. The condition known as poorness is a *physiological* state which may be present in animals and carcases which are perfectly healthy and free from disease, and in which all the organs are quite normally developed. Indeed all animals, at one stage or other of their existence, for example, in their very early youth, are more or less poor. It is, therefore, a question of nutrition and growth, not a question of the results of morbid processes. The correct scientific word to describe the state of such an animal would be *hypoplasia*, and the actual histology is that the cells composing the tissues are either too few in number or too small in size, or are commonly a combination of both these. Associated with this is the important other fact, namely, that the total amount of fat present in a poor carcase is extremely small in proportion to the size

of the carcase itself. It is this fact—the absence of a due amount of fat —which causes the inspector to decline to allow the carcase to proceed for sale to the meat market, because it is assumed that the meat-purveyor in offering any meat for sale thereby enters into an understanding with his customer that that meat is at least of normal quality as regards health and nutritive condition. The absence of a normal quantity of fat in meat is a breach of this mutual understanding, though, at the same time, it should clearly be recognised that meat in such a state of poorness is not in the least less valuable for purposes of nutrition than other meat. What it does lack, however, is the quality and flavour which are associated with good butcher meat, and which depend upon the presence of a certain quantity of fat for their existence. The flavour of poor meat after cooking is distinctly less agreeable to most palates than that of fattened animals, as all will agree who have had any experience of the meat in many continental countries, where it is no unusual thing for the cattle to be bought straight off the farms and slaughtered for food at once without any previous fattening. This meat shrinks considerably during the process of cooking, is much less tender than fattened meat, and decidedly of a less pleasing taste, being distinctly insipid.

The Justification for Condemning Poorness. These facts are the justification for the inspector withholding such carcases from sale, not that there is any danger of any actual disease from eating a poor carcase. Nor need anybody require legal or other protection from the vendors of poor meat so long as the purchasers have the opportunity of themselves seeing the meat before they purchase it, because no housewife of any pretensions to efficiency could possibly be deceived into purchasing such meat under the idea that it was thoroughly fattened. The absence of fat is obvious if it is looked for, and there appears no reason why in such cases the meat should not be sold *at its own value* (which, of course, is less than that of fattened meat), and thereby create or supply a demand for meat of this quality. In addition to the absence of the fat tissue, the muscles themselves are somewhat firmer and tougher than in fattened cattle, and, when the meat is cut across, it is darker in colour than usual. This poor meat has a definite value for certain purposes, such as those of the manufacture of sausages and minced meat, and the difficulty as regards its quality and taste is obviated by the manufacturer by means of adding a certain quantity of lard. The only objection to the sale of such meat which has any real weight is that the inspector may not always be in a position to determine whether such a carcase is really a case of poorness, or whether it is one of emaciation as the result of disease. We are, however, of opinion that this objection is not really a serious one provided that the duty of meat inspection is placed in the hands of those thoroughly trained for that purpose. The objection is reduced to a minimum where the inspector has the opportunity of examining the animal during life, or all the organs after slaughter, and in any case he always has the option, if there is any doubt in the matter, of withholding the carcase from sale.

Causes of Poorness. The causes of poorness may be briefly summarised as follows: Failure on the part of the animal to assimilate food, as in senile decay; immaturity and under-development in all animals in early youth; in most male breeding animals such as bulls; during the process of lactation in cows of the breeds especially used for milking purposes, and finally in all cases of starvation or insufficient food-supply. It will be noted that these are physiological, not pathological factors.

Emaciation. In opposition to the condition of poorness, emaciation is a definitely *pathological* condition, not a physiological one. It is the result of some morbid process or other, an actual diseased condition as the result of which the animal loses flesh and fat. Tissues which at some previous stage of their existence were present in normal amount and quality have now become atrophied.

Signs of Emaciation. Thus there is an absolute loss of the fat which has accumulated during the time of fattening and also a distinct atrophy of the organs themselves, including the muscles. The internal organs which show most distinctly this atrophic process—besides the loss of fat—are the liver and the spleen, both of which are reduced in size. The muscles themselves exhibit an absence of fat between their fibres, and their consistence is somewhat reduced, giving them a flabby and soft feeling. It follows also, of course, that the atrophy of the muscles causes some considerable alteration in the shape and contour of the parts specially affected. There will be sunken areas which should be filled with firm solid muscle, and depressions where there ought to be convexities.

More important still (because an unmistakable indication for the inspector to condemn the carcase) is a serous infiltration of the subcutaneous tissues, especially those in the posterior part of the abdominal cavity, and a similar infiltration of the connective tissue between various muscles. Along with this is found a gelatinous kind of material where there should be fat, and instead of the normal colour of the meat itself there is frequently seen a greyish red appearance which is distinctly striking.

Judgment of Emaciation. The judgment of the inspector in all these cases of emaciation must be based upon his opinion of the actual cause which has produced the condition; but whatever that cause may be, and whatever doubts he may have in his mind from the presence or absence of the various signs above mentioned, all authorities are agreed that in the presence of the serous infiltration just referred to there is no option at all for the inspector. Unhesitating condemnation must be the verdict. This "slimy" degeneration, as it is sometimes termed, without question renders the meat absolutely unfit for human consumption, and it is a safe rule for the inspector to act upon to condemn all emaciated carcases in which he is satisfied that the distinction between this and poorness is thoroughly established, and that he is dealing with a carcase which has been brought to its present condition as the result of a distinct morbid process.

Causes of Emaciation. The causes of such emaciation as lead the inspector to reject such a carcase are numerous. In cattle tuberculosis, of course, especially in its chronic forms, is responsible for the greatest number. In sheep most emaciated carcases are found to be associated with the presence of advanced disease of the liver caused by the liver fluke. In addition to these two very common causes of seizure, there are many less well-defined conditions which point to the presence, over a considerable period of time, of some toxic condition of the body. All the so-called wasting diseases produce emaciated carcases if the condition is present long enough. Prolonged gastric and intestinal troubles, rendering it impossible for the animal to digest its food, produce a similar result. Profound alterations in the condition of the blood interfering with proper oxygenation and nutrition act in a similar way. Many other conditions will suggest themselves as possible causes of emaciation, but it is only necessary to repeat that the general rule for the inspector should be to condemn all carcases exhibiting the signs above described, which in his own mind he can distinctly associate with the presence of actual disease.

Immaturity. Amongst the causes of the seizure of the carcases of young animals at the slaughterhouse, perhaps the most common is that of immaturity. Here again we have to deal with a question in which the judgment of the inspector is left largely to his own individual discretion within certain limits. There is no definition of immaturity which is accepted in exactly the same way all over the country, though there are certain carcases which all regard as immature. Thus all fœtal carcases are seized everywhere, and perhaps the most general rule in Great Britain is to regard all young animals as being immature before they have arrived at the age of from *eight to fourteen days*, some considerable variation being made in different centres between those two dates. In South Germany the minimum age at which calves are allowed to be exposed for sale is from three to four weeks, whereas in other districts such as Mecklenberg, calves of three or four days old are readily dealt with, and in Berlin calves from six to eight days old are highly valued for food. This is probably due to the fact that the cost of the meat of calves at such an age is considerably less than that of the same animal a month or two later, owing to the cost of rearing for that period, and therefore by utilising the calf only a week old it becomes possibly for sections of the community (which could not afford the price at a later period) to partake of veal, which they otherwise could not do. In addition to this reason, it must be remembered that in many places on the Continent the dairy system is carried on to an immense extent, and would involve the destruction of a great number of immature carcases of calves unless they were made use of in this way. In most parts of Germany, meat from calves is regarded as immature up to from eight to fourteen days. The same period is a very common one for recognition in Great Britain.

Fœtal Carcases. As far as we are aware the meat of a fœtus is never exposed for sale except under false pretences. Fœtal carcases are always

seized and condemned in spite of the prevailing opinion on the Continent to the contrary, namely, that the meat of such carcases is greatly esteemed among English epicures. This is one of those impressions in the minds of our friends abroad for which it is somewhat difficult to find any reliable evidence. There is no doubt that it is quite true that a considerable number of such fœtal carcases, especially from cows, are offered for sale in those districts in which there is an entire absence of meat inspection or where that inspection is utterly insufficient.

Signs of Fœtal Carcases. The signs of a fœtal carcase, provided that the whole carcase is present, are unmistakable. The whole carcase is sodden and wet, the umbilical cord (or its remains) is present, and its vessels are open. The hoofs obviously indicate that they have never been used for walking, and the eyes are closed. Some of these parts, however, may be absent, having been already removed. For instance, the skin may have been taken off and the hoofs and the head along with it. Nevertheless, there is no difficulty in the inspector recognising the nature of the carcase he is dealing with. He has only to turn his attention to the lungs to find that they are in a condition of *atalectasis*, never having expanded and therefore absolutely devoid of any air. As a result, when placed in water, they sink immediately. Moreover, the condition of the urachus and the open state of the vessels of the umbilicus afford further information. Apart altogether from these growths and anatomical distinctions, the condition of the muscles themselves is very characteristic, being watery and flabby in consistence. The absence of any large quantity of fat in the region of the kidney will also be noted, the connective tissue in that part being gelatinous. In the long tubular bones the marrow will be red. Chemically, also, it can be shown, if necessary, that the amount of glycogen present in the meat of a fœtus is considerably greater than that of ordinary muscle.

Determining the Age in Calves. The inspector may often feel it necessary to come to a conclusion in his own mind as to the actual age in the case of a calf, before determining his judgment finally. For this purpose the following points may be borne in mind. The new-born calf exhibits soft hoofs which are covered with conical processes on the sole. The stump of umbilical cord still exhibits a moist character and is firmly attached to its ring. The vessels in that situation may still be open. On examining the mouth, the gums will be found to be at the same level with the incisor teeth, the latter of which are practically covered by them. The number of these teeth present in calves at birth is usually six, but may vary. During the days which follow the birth of the calf certain changes occur which furnish the inspector with evidence as to age.

The navel appears brownish or black in from four to five days; the cord dropping off within a fortnight, often between eight and twelve days, the wound becoming healed up in from two to three weeks, and the retraction of the navel appearing after a month. Should there be any disease all these processes will be correspondingly delayed. According to Morat the falling off of the cord in calves showed the following variation

in fifty cases collected by him: in seven cases, between fifth and tenth day; in twelve cases between tenth and fifteenth day; in twenty-four cases between fifteenth and twentieth day; in seven cases between twentieth and twenty-second day.

The teeth also furnish valuable evidence as to age. The corner teeth appear usually during the first week, but in odd cases a little later. The incisors become free from the covering of the gums in about ten days, after which the gums appear of their normal form. In a fortnight the middle incisors are free, and after twenty days the only teeth which are still embedded in the gums are the two corner teeth. At the end of a month all have penetrated the gums.

Appearance of Horns. Gerlach attaches some importance to the appearance of the formation of horns as an indication of the age of the calf. According to him the epidermis over the frontal bone begins to thicken at the end of the second week, and by the end of the third week has formed a definite hard swelling. In six weeks there is a well-marked nucleus of a horn, and in eight weeks the horn cap has developed. At the end of three months, a movable horn point appears, three centimetres long in bull calves and two centimetres in heifer calves, these figures being increased to four centimetres and three centimetres respectively after four months. He also states that the horn tip is fixed in bull calves after four months, while in heifers it becomes attached only after five or six months.

Arguments against using Immature Meat. It is a somewhat difficult matter to say on what scientific grounds the meat of these immature animals is to be rejected as unfit for human consumption. They are in a condition of physiological undevelopment, but it is a very fine distinction which condemns such a carcase on one day and allows of its exposure for sale the next.

It is maintained by some that the consumption of immature meat of this character in human beings is followed by gastro-intestinal disturbances, causing amongst other things diarrhœa and other discomfort. We are not at all satisfied that there is any reliable evidence to prove that this is the case. It would appear rather that the actual justification for the rejection of such meat should be based upon the broad general principle that the meat-purveyor in exposing meat for sale is assumed thereby by the purchaser to be offering fully developed normal meat of an ordinary standard and of ordinary constituents. Moreover, there is not the slightest doubt that the majority of people have a distinct mental repugnance to consuming meat of this undeveloped kind, but at the same time this mental attitude is a matter of considerable variation in different localities and different countries. As a matter of protection for the public, and in order to prevent immature meat being substituted for full-grown meat, it may be taken as a good rule that calves should not be allowed to be offered for sale until they are at least eight days old.

EMERGENCY SLAUGHTER AND NATURAL DEATHS

If we were asked to state which kind of carcases demand the closest scrutiny and most careful attention from the meat inspector in order that the public may be protected from the serious effects of using bad meat as food, we should reply, without hesitation, that it was the group of cases which come under the heading of this section. There may, or may not, be serious danger to the public from the meat of tubercular animals; emaciated carcases may, or may not, offer some risk to the consumer; but of all the cases which in our opinion throw upon the inspector a real responsibility and require great discretion in judgment, the most important are those which are "killed to save their lives," as the slaughterer puts it. They are, also, among the most difficult of all the conditions upon which the inspector has to pronounce, for the simple reason that in many of them he is not dealing with any one definite and specific infection, but with a general condition of fever or septicæmia. In almost all cases the disease, whatever it may be, from which the animal is suffering, is so serious as to threaten its life, and the owner, therefore, in the quite legitimate hope that the flesh, either partly or entirely, may be found fit for food, has the animal slaughtered before death occurs. Hence the popular expression to which we have alluded. Practical meat inspectors, we are sure, will agree that the great majority of these emergency cases require seizure and condemnation. Amongst them are to be found by far the most filthy and repulsive specimens which are ever seen in the condemned meat room of the slaughterhouse. In many, but by no means in all, the smell of the carcase is extremely repulsive. Certainly no cases are of greater importance from the point of view of the public health. Bollinger, on the Continent, drew attention to the fact that those epidemics which resulted from eating the meat of diseased animals were in at least four-fifths of the instances associated with emergency cases of slaughter. That statement by itself places in its proper position the serious duty of the meat inspector in this connection. Whatever else he may pass or condemn, and in whatever cases his individual opinion may lean to the one side or the other, here at least he must be particularly careful and stringently severe. His difficulty lies in the fact above mentioned, that he is frequently dealing with conditions which are not definite, or typical, and whose origin is frequently obscure.

Appearances in Emergency Cases. In the absence of any known, definite, and specific cause of the condition, the inspector must base his judgment upon what he sees before and after slaughter; for this is eminently one of those cases in which the inspection of the living animal is of the very greatest importance. The presence or absence of well-marked fever, together with much weakness and general signs of depression, will be observed; and it will be remembered that, in cattle, any great rise in temperature during life is restricted to specific infectious diseases or those which are definitely of a septic nature. After killing

and dressing, the internal organs call for careful inspection, and if it be found, as frequently happens, that there are no gross lesions in the internal organs, the inspector will at once suspect that the condition was one of a general septic nature. The liver will be found to exhibit a condition of cloudy swelling, being somewhat pale and swollen, though congestion may possibly be present. The same remark applies to the kidneys and the heart. Most of the lymphatic glands are enlarged, soft, and œdematous, showing a watery surface when cut across. One of the most valuable indications in these cases is to be found on examination of the serous membranes, especially those of the lungs, heart, and abdomen. Scattered throughout these membranes are generally found a number of *minute dark spots* which, on close examination, prove to be minute hæmorrhagic points. These are characteristic of submitted septicæmic conditions, and are due to a rapid degeneration of the walls of the capillaries, as the result of which there are minute extravasations of blood at the degenerated spots. Patches of focal necrosis may be found in the liver, which also point to serious toxic conditions.

It will be seen, therefore, that the diagnosis in these conditions requires expert judgment. Only an inspector who has a thorough knowledge of pathological science can appreciate the general conditions and the absence of gross lesions in these extremely serious cases, which are undoubtedly those which offer the greatest risk to the general public. It is in cases of this sort that the defects of our methods of inspection are so obvious. No provision is made in this country for classifying inspected meat; whereas, if this were done, carcases such as we have been describing would always be sold, if sold at all, under declaration.

Delaying Final Judgment. The duty of the inspector, moreover, is not at an end when he has made his first examination of a carcase slaughtered in emergency. The condition may be such that in his opinion he is not justified in condemning the carcase at once for destruction. It will almost always be found that these carcases bleed very imperfectly. That means that their keeping quality is impaired, and experience shows that such carcases are extremely liable to rapid decomposition. They should, therefore, be kept for a day or two, in cases in which there is any doubt, in order to determine how the carcase sets, and whether decomposition is ensuing quickly. In no case should the meat be kept long, nor should it be allowed to be made into sausages. Since, in this country, it is difficult or impossible to trace the future history of such a carcase when once it has left the slaughterhouse, the only advice that can be given to the inspector is to err on the safe side and pass nothing of this nature likely to be injurious. The suggestion has been made abroad that no carcases from emergency slaughtering should be permitted to be sold by ordinary meat-purveyors, but only in special places under police or other control.

Meat Poisoning from such Cases. Lest it should be thought that we have laid undue stress upon this matter, we would refer our readers to the literature of meat poisoning in human beings, especially that from the pen of Bollinger, in whose various writings will be found summarised a

large number of outbreaks of meat poisoning affecting many individuals, most of which are associated with emergency slaughter. Ostertag gives a summary of no fewer than forty important epidemics of meat poisoning traced to cases of this nature, occurring during the last twenty years, and similar experiences fall to the lot of most medical officers of health in large centres of population. The illness produced in those who partook of the meat varied immensely in nature and seriousness. As Bollinger says: "The number of undetermined infections, intestinal infections, the cause of which is chiefly found in the food, is, even in adult persons, much larger than is commonly assumed. As a result of eating meat which comes from diseased, especially septic food animals, pathological conditions are produced, which, with regard to their course and also with regard to their anatomical alterations, show a great variation. All transition stages exist, from simple digestive disturbances, gastric catarrh and summer cholera, to serious febrile attacks, which at times appear under the form of the so-called pituitous fever, gastric fever, ileo-typhoid or dysentery. To the domain of meat poisoning belong probably many other cases of sickness which assume the form of petechial typhoid or febrile icterus."

A Test of Meat. We have already drawn attention to the vagueness of the clinical and pathological signs so often associated with these dangerous conditions. We have pointed out the advisability of retaining the carcase for the purpose of observing the outset of any rapid decomposition which points to the presence of septic disease. There is, however, a positive test apart from bacteriological investigation, which may readily be applied and which may be taken to afford a basis upon which to come to a decision. "If the meat of animals, slaughtered on account of disease, shows an alkaline reaction within twenty-four hours after death, the meat is to be considered, in doubtful cases, as unqualifiedly foul, and therefore unfit for food. Likewise in doubtful cases, the unfitness for food of the meat of animals slaughtered on account of disease is unquestionable, if, within forty-eight hours after death, the muscle fibres show under the microscope a loss of their characteristic cross striation, a granular cloudiness, and a disintegration into fragments. If, even after all these points are considered, doubt arises concerning the fitness of the meat for food, it appears desirable that a decision in the matter should not be reached in summer before twenty-four hours, and in winter not before forty-eight hours after slaughter. Experience teaches that within this period in cases of septic and toxic poisoning, such conspicuous abnormal alterations of the meat appear with respect to its colour and odour as to furnish sufficient criteria for judging the character of the meat in doubtful cases" (Ostertag). We would urge upon inspectors that they should make the above procedure their uniform practice in dealing with such cases.

Signs of Natural Death. Still a good number of deaths occur without the intervention of the slaughterer, and it is to be feared that a good many of the carcases of such animals, especially in country places, find their way into the meat-market. There is no great difficulty in diagnosing the fact that death has occurred without artificial interference, pro-

vided that the animal is seen soon enough. Thus the usual marks of the instrument of slaughter, whether it be pole-axe or other apparatus, will be absent, and unless there has been a more or less abortive attempt to bleed the animal after death, the throat will be intact. The striking feature in death from these natural causes is the imperfect bleeding, if, indeed, any has occurred, and, if not, then all the tissues of the body are found to contain a large quantity of blood. This will be particularly obvious in the internal organs and especially, of course, in those which most readily show congestion in diseases. Thus we shall find a congested liver or lungs. There is, in addition, a staining of the tissues from blood, the situation of which will depend upon the attitude of the animal at the moment of death. This is termed hypostatic, and depends, of course, simply upon the blood gravitating to the lowest point. The small subcutaneous vessels of the skin are always found to be full of blood, even when bleeding has been attempted almost at the moment of death.

The whole carcase is unusually soft and moist, on account of the absence of bleeding ; and externally, after skinning, generally shows a blotched or reddened appearance. As in all other cases of imperfect bleeding, decomposition sets in much more rapidly than in bled carcases, and this is detected by the changing colours, particularly in the fat, which assumes a greenish tinge. This is especially well seen in the fat surrounding the kidneys in sheep and cattle. The general appearance is well seen in our coloured plate (Plate XV.).

Judgment in Natural Death. Much of what was said in connection with emergency slaughter applies with equal force to cases of natural death ; because, as will readily be understood, the two groups of cases are frequently pathologically identical. That is to say, that in many of the cases which are brought to the slaughterhouse for emergency slaughter, the animals would have died naturally had they been left a little longer. The same considerations, therefore, which were laid down as being of importance in the former, apply equally to the latter. In the great majority of cases, the inspector will have no hesitation whatever in seizing and condemning the carcase ; and the complete justification of this procedure, apart altogether from exact pathological knowledge, is to be found in the fact that *no one would buy willingly for food meat from an animal which they knew to have been found dead.* We are not here referring to cases of death from violence, or accident, or lightning, or other traumatic causes. Most of these present no difficulty to the inspector, and it will usually be sufficient to seize only that portion of the animal to which the violence was directed ; since, on account of the bruising and contusions, such parts readily decompose. These injuries, however, may be quite local in character, even though they produce death, and the rest of the carcase may be found to be perfectly sound. The point to be remembered once more is that from imperfect bleeding or absence of bleeding the meat will not keep well. Each case of this sort must be judged upon its merits, and no general rule can be laid down.

The Worst of all Carcases. We have purposely omitted from the above list of dangerous fallen carcases and emergency cases those which,

in our opinion, constitute the worst class of all bad carcases. By placing them in a paragraph by themselves it is hoped to thereby emphasise their importance. We refer to the carcases of animals, especially cattle, which have died *after parturition*, as the result of imperfect cleansing at the time of the birth.

Medical men who are also medical officers of health will readily recollect what terribly septic cases ensue in human beings when the after-birth is not all removed from the uterus after birth, and subsequently undergoes septic decomposition. Nothing is more terrible in human practice than these septic puerperal cases, now happily rare. The same is true in the case of cattle, and no man who had experienced such a case in clinical practice would think of permitting the flesh of such an animal to be sold for human food. Many such carcases come under the notice of the inspector, and, as we say, they constitute the worst cases with which he has to deal. They should be rigidly seized and condemned without fear or favour. They decompose with great rapidity and with a most offensive odour, and have no claim whatever to be dealt with otherwise than by complete destruction.

Septic parturient fever is simply an acute septicæmia of the most aggravated type. It differs from parturient paralysis of cattle, which usually comes on in from twenty-four hours to three days, and is of the nature of a toxæmia. In this latter condition there are no gross anatomical lesions and the cases are frequently those in which the parturition has been easy. They are fairly common, and as far as is known no harm has followed the partaking of the meat from such carcases. In septic parturient fever, on the other hand, the pathological condition present is that of an acute *septic endometritis*, with general rapid septicæmia, and the carcase presents a picture which once seen cannot easily be forgotten. In parturient paralysis the meat is doubtless of inferior quality, and should only be sold as inferior meat. As this cannot be done in this country, it had better be withheld from sale altogether.

Natural Deaths. As used in meat inspection, the term "natural death" does not mean deaths which occur in the ordinary course of events from old age, but deaths which take place in animals as the result of disease. These cases are often spoken of as those of fallen animals. They include all those conditions in which, from some reason or other, the animal is either found dead or dies before it can be brought to slaughter. It will, therefore, be at once obvious that it comprises a group of conditions which is on all fours with that of emergency slaughter as regards the careful scrutiny demanded on the part of the inspector. These so-called "natural deaths" are not very common amongst cattle, for the simple reason that whenever these animals seem to be tending in the direction of death, the owner has them slaughtered as soon as possible, in order that they may be passed as fit for food before they reach such a condition as would inflict upon him the total loss of their value as meat.

CHAPTER VII

TUBERCULOSIS IN MEAT ANIMALS

The whole problem of meat inspection is so largely concerned with this disease that no apology is required for devoting a special section to its consideration, more especially in view of the fact that the question of the identity of human and bovine tuberculosis has been, and is, so much to the fore, as well as the question of the prevention of the spread of the disease amongst human beings and cattle.

There is probably no question in the pathological world which is receiving so much attention at the hands of scientists and sanitary authorities as that of tuberculosis. We shall, therefore, deal with this subject considerably more fully than in the case of any other disease.

Occurrence of Tuberculosis. Tuberculosis is a chronic infectious disease caused by a specific microbe, which affects probably all the vertebrate animals (even including fish) in a greater or less degree. It is far the most common disease in human beings, so much so indeed that it has been estimated that from one-seventh to one-tenth of the whole human race perish from one or other form of it. From the standpoint, therefore, of the fitness of food for human consumption its importance cannot be exaggerated, and whatever else the meat inspector knows or does not know, he must be perfectly familiar with all the very varied forms in which this disease makes its appearance in the various animals which come under his notice. Although none of the domesticated animals escape, there is considerable variation in the relative frequency with which it occurs in them. Though it is extraordinarily common in bovine animals, it is also a very frequent condition in swine, while it is a comparatively rare thing to encounter it in either sheep or horses. It may be mentioned in passing that a popular idea to the effect that the goat was immune from tuberculosis is not correct, although the disease is rare in that animal.

Variations in Frequency. Many general considerations are doubtless responsible for the very varied frequency with which cattle are affected in different countries, or in different parts of the same country; and there is no doubt that those which deal with the principles of all infectious disease account for the differences which are found. That is to say, that in this condition, as in other conditions, other things being equal, it will be found most common where the cattle are herded closely together and under conditions in which they are ill-fed and kept in byres or other indoor situations where free and adequate ventilation is not provided.

Probably, too, continued close contact with human beings may have its share in the origination of some cases of tuberculosis. On the other hand, where the animals live a free open-air life all the year round, and where they are not overcrowded and food is ample, there we should expect to find, as we do, comparatively few cases of tuberculosis. One has only to compare the relative percentages of the cattle affected with this disease in countries where the climate is so mild that they can run outside all the year round, with other countries where the winter is so severe that they are herded closely together in buildings for protection from the cold and where the cattle are hand fed, to observe the importance of this distinction.

Heredity and Tuberculosis. Lying behind and deeper than all this, however, is the question of the purity and freedom from the disease of the stock from which any given herd of cattle has sprung, in other words, the question of *heredity*. Tuberculosis is one of those diseases which, although not inherited in the accurate scientific use of that much-abused word, shows a very distinctive preference for some animals and pedigrees over others. This applies both to animals and human beings, for there is unquestionably in some individuals a considerable tendency to the disease which renders the individual much more susceptible to infection than are others of the same species. Although this fact renders it very difficult to keep animals anything like free from the disease, it nevertheless offers the only hope of eradicating it in any given area or country. If it were not for the fact that some animals are much more resistant by nature, that is to say, *by inheritance of resisting quality from their ancestors*, the outlook from the point of view of the breeder would be hopeless. But inasmuch as we know that inborn qualities of this kind are transmitted from generation to generation by means of the continuity of the germ plasm, there is every chance for the scientific breeder who will take the trouble to apply his knowledge to his everyday work to succeed in breeding a tubercular-free stock.

The Value of Tuberculin. Science has placed in our hands in the shape of tuberculin an agent which enables us to diagnose the presence of tuberculosis, even in an animal in which there are no external signs of the disease, and, moreover, in which the internal signs cannot be discovered during life. If this test be applied regularly and uniformly in any herd which is used for breeding purposes, and those animals which react are carefully excluded from having any share in the production of future offspring, it is quite obvious that that herd will become more and more resistant to the disease, simply because only those which are by nature more resistant to infection (because otherwise they would have become affected) would be used for the purposes of breeding. But so long as breeders continue using all sorts and conditions of cattle indiscriminately, quite apart from any scientific test of their relative susceptibility or immunity to the infection of tuberculosis, so long will there be very little improvement or reduction in the number of the cattle affected.

Relative Frequency of Tuberculosis. The following facts will serve to show that it is chiefly amongst cattle and pigs that tuberculosis in our food animals has to be considered. Probably from 20 to 30 per cent. of cattle in Great Britain are affected to a slighter or greater degree with the disease. This proportion varies immensely not only with the general principles already enunciated, but particularly with regard to the age of the animals. Thus we find that very young cattle, that is, up to one year old, are affected only to the extent of about .05 per cent., a figure which rapidly increases with every succeeding year. To such an extent indeed is this so, that in old milch cows of an age of ten to fifteen years the percentage may rise as high as 75 per cent. In the case of pigs, the percentage of infections is not nearly so much, but the disease either becomes so much more readily generalised or so much more quickly that tuberculosis in swine must be regarded almost as important as in the case of cattle. It is estimated that the percentage in swine is from 4 to 5 affected. No figures are available for any accurate statement as to the percentage of the disease in the case of birds. It should be remembered, however, that fowls, turkeys, ducks, pheasants, and all domesticated birds are liable to become affected with avian tuberculosis, though whether this form of the disease is transmissible to human beings is very doubtful. In fowls, however, it frequently causes destruction of large numbers, becoming even epidemic. The organism here has probably become modified by a long sojourn in the annals of birds, and so has assumed special characters of its own. The same is probably true in the case of bovine animals. Tuberculosis in the case of sheep and goats occurs in only about .002 per cent. of these animals. It is rare to find rabbits in a state of nature affected with tuberculosis, nor do they take it readily in confinement, though quite readily by means of inoculation.

Horses are generally thought to be comparatively free from tuberculosis, about 1 per cent. only being affected.

Note. Since horse-flesh is not a common source of meat for food in Great Britain the question of tuberculosis in them is not of any great importance to the meat inspector.

It may be interesting, however, to know that the present writer has in his experience found equine tuberculosis to be considerably more common than is generally thought.

In his opinion it is one of those conditions thought to be extremely rare, chiefly because it is very seldom looked for.

Signs and Symptoms of Tuberculosis. There is, perhaps, no one thing which makes such a vivid impression upon the mind of the junior student of meat inspection as does the *astonishingly good condition* of a great many animals which, when slaughtered and opened up, are found to be full of tuberculosis. Owing to the knowledge that in human cases of consumption the patient almost always exhibits a considerable amount of emaciation, he is apt to suppose that the same thing would be the rule in cattle. As a matter of fact, however, even when the changes

FIG. 1.—ADVANCED BOVINE TUBERCULOSIS: A "PINER"

FIG. 2.—LOWER END OF RIGHT EIGHTH AND NINTH RIB OF A COW

With corresponding costal cartilages. Tuberculosis, inferior intercostal lymphatic gland exposed by reflection of parietal pleura, on which there is also a deposit of tuberculous nodules (grapes). (Preparation by S. Delépine.)

caused by the disease are deeply situated, there *may be no external visible signs* at all pointing to their existence, and the infected animal, to all appearances, is in perfect health, and is usually thoroughly well fattened. Thus it occurs that in a large number of cases there is not the slightest suspicion that the animal is tubercular until after it is slaughtered. The farmer sells the animal all in good faith believing it to be free from disease, the butcher buys it because, to all appearances, it is healthy. It is on account of this state of affairs that the agitation in connection with warranty of cattle is at present so much to the fore, and it would appear that the simplest and fairest manner of dealing with the whole question would be by the institution of a universal system of insurance in which all those concerned contribute on an equal basis. This question is discussed fully later. There may, however, be certain symptoms present which will draw attention to the existence of the disease. Thus the coat may be rough, the skin harsh and tight, the animal may be coughing, and the glands in the neck, in the groin, or above the udder, may be so much enlarged as to be easily felt ; any or all of which symptoms will give rise to suspicion of the disease. In very severe, rapid, general tuberculosis (which corresponds to galloping consumption in human beings) the signs are unmistakable, and here the extreme emaciation associated with consumption is to be found. There is a rapid loss of flesh, diminishing appetite, increasing cough, progressive weakness, quick breathing, increased rate of pulse, some elevation in temperature and enlargement

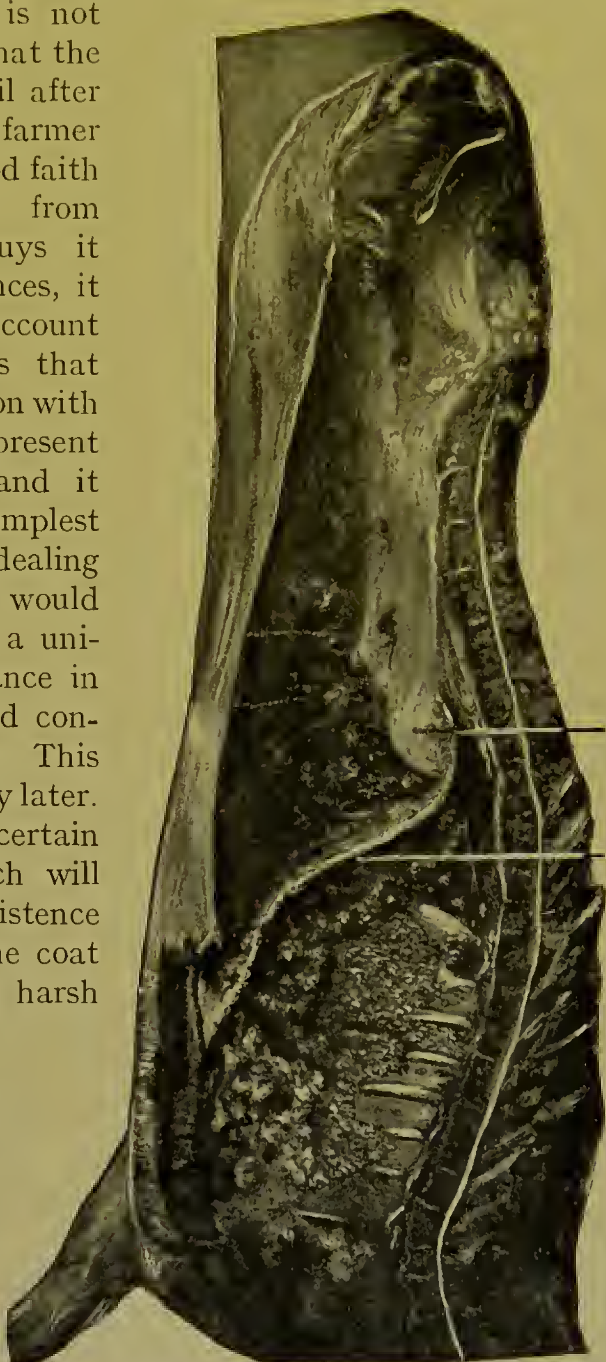
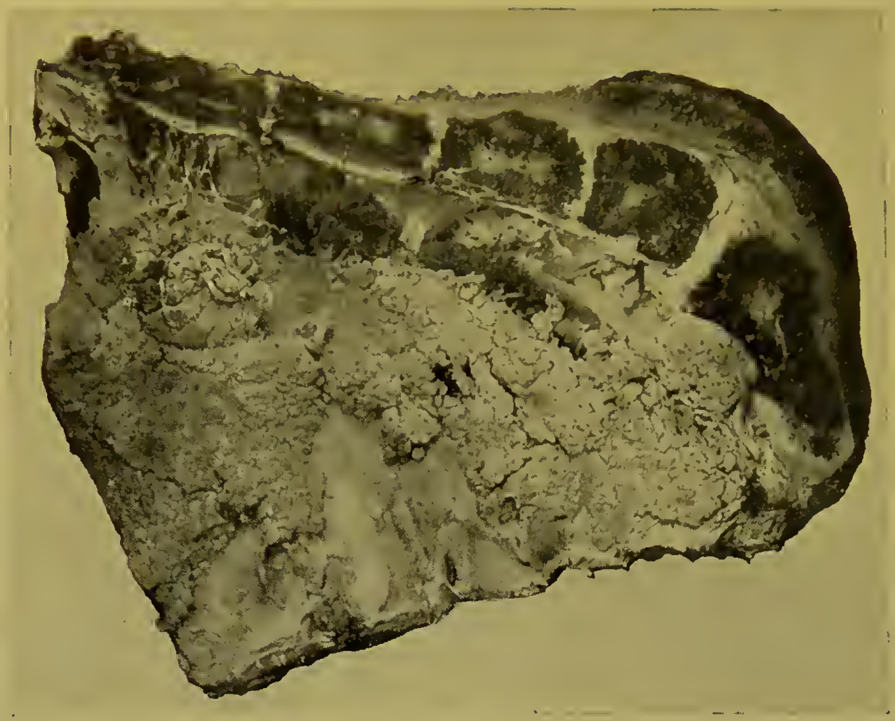


FIG. 3.—BOVINE TUBERCULOSIS (PERLSUCHT)
The deposit is both peritoneal and thoracic.



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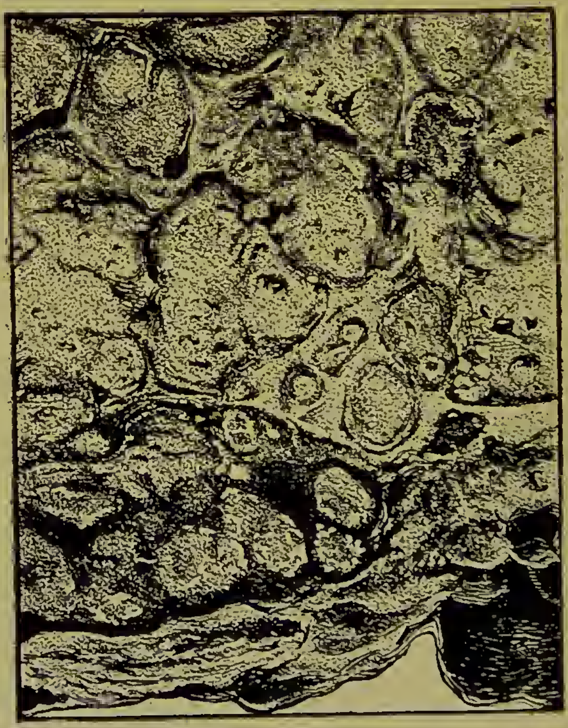

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Fig. 4.—Advanced Tuberculosis of Pleura (Tubercle Bacilli)
(Preparation by S. Delépine.)

Fig. 5.—Bovine Tuberculosis (" Grapes ")
Nodules on the pleura in a cow.

Fig. 6.—Section of Tuberculous Lung of a Cow
The light-coloured points are areas of calcification ; the rest is caseous.

Fig. 7.—A Case of Tuberculosis in the Mesenteric Glands of a Pig
Glands incised.

of various lymphatic glands. This is the form of tuberculosis which results from a rapid dissemination of large numbers of tubercle bacilli throughout the circulation or the lymphatic vessels.

Common Forms of Bovine Tuberculosis. The two most important forms of bovine tuberculosis are those associated, first, with the lungs and, secondly, with the serous membranes. It is in the tubercular broncho-pneumonia that there are observed in acute cases the frequent cough and the tubercular breathings, sounds which are characteristic of the disease. The condition of the animal as regards nutrition is by no means a reliable guide, there being perhaps no very marked emaciation unless the case be very severe.

Grapes or Perlsucht. In the second most frequent form of the disease, namely, that affecting the serous membranes (the so-called "pearl" disease), it is only in the most advanced stages that external symptoms will be sufficiently obvious to attract the attention of the inspector before slaughter. It is perfectly astonishing to what extent tuberculosis of the pleura and the peritoneum may be present without any suspicion of the disease occurring until the examination of the carcase. Huge masses of tuberculous deposits may, and often do, occur along with a splendidly fat carcase which looks otherwise healthy. Apart from these two forms of the disease, there are others which may be recognised with certainty before slaughter occurs. For example, the udder may be diagnosed as tubercular by its swollen condition, due to the firm tuberculous nodules which are present in one or more of its quarters. It is not usual, though it does sometimes happen, that the whole udder is affected. In other cases there may be enlargements or thickenings of the joints and glands, which can be observed by external examination. Caseation and calcification are apt to occur in any tuberculous area which has been existent sufficiently long, and it is an important matter to recollect that tuberculosis affecting the serous membranes is specially liable to early calcification. This applies particularly to cattle.

Tubercular Lesions. The morbid changes which follow upon the introduction into the system of the tubercle bacilli may be either primary or secondary. Primary lesions are those which arise immediately at the point of entrance of the organism or close to that point, simply as the result of the irritative action of the germ upon the tissues immediately in contact with it. Neither the circulation nor the lymphatic system has in such a case played any further part in the distribution of the infecting agent.

Primary Lesions. These primary affections, therefore, will be found especially on the mucous membranes of the respiratory or the alimentary tract, representing the points at which the organisms find a lodgment after they have been inhaled or swallowed respectively. From these primary points tuberculous lesions may be found spreading by means of direct extension of growth. Such forms of the disease are particularly characteristic in young cattle and in swine where the primary point of infection has been at some part of the digestive tract. In older cattle

primary lesions are usually associated with the lungs giving rise to tuberculous broncho-pneumonia.

Secondary Lesions. Secondary lesions, on the other hand, are those in which the organisms have found their way either into the blood-stream or some lymphatic vessels, by means of which they are disseminated throughout the body, coming to rest in the capillaries or lymphatics of one or other of the internal organs. In opposition to the alimentary tract and the lungs these latter organs have no direct communication with the external world. It must be remembered that both primary and secondary lesions may exist together in the same case, and that the former may give rise to the latter.

FIG. 8.—SMALL INTESTINE OF COW, SHOWING LARGE TUBERCULOUS ULCER

Production of Tubercle Follicles. Once the tubercle bacilli have found their way into the body and settled at any given point whether directly or as the result of being transported by blood- or lymph-streams, they proceed to produce the characteristic product of their action which, in the first place, is a tubercle follicle. This is caused by the multiplication of the organism and by the irritating effects of the presence of the germ upon the tissue immediately surrounding it. This follicle is composed of various cells which are derived from the endothelium lining the blood-vessels or lymphatic vessels, together with the delicate connective tissue of the part. As these elements undergo proliferation, a certain number of leucocytes are attracted to the spot, becoming incorporated in the small follicle. This proliferative process goes on until the follicle gives rise to the so-called "miliary" appearance, at which stage it is of greyish translucent character. The follicle so produced contains no blood-vessels ; it is simply a mass of cells arising from multiplication of those already present, which cells mass themselves into a small heap which makes the follicle. The growth continues at the periphery, and as it progresses it follows of necessity that the cells composing the central part of such an area will tend to die from lack of adequate nutrition. This is one of the causes of the characteristic death or caseous necrosis which takes place in the central part of all tuberculous areas.

It is, however, not the only factor which causes that death. Not only are the bacilli multiplying within the area, and especially in the outlying portions, but they are also producing their toxins, and these latter exert their influence locally upon the cells composing the tuberculous area, thus materially assisting in the production of caseation necrosis.

A tubercle follicle in this stage is said to show easeation in its centre.

Production of Large Tubercular Masses. It ean readily be understood that if a large dose of bacilli, in other words, a large number, find their

Fig. 9.—Bovine Tuberculosis, Pulmonary

Note that the pericardium in this case is free from the disease. This is the rule in man but in cattle it is commonly affected exteriorly.

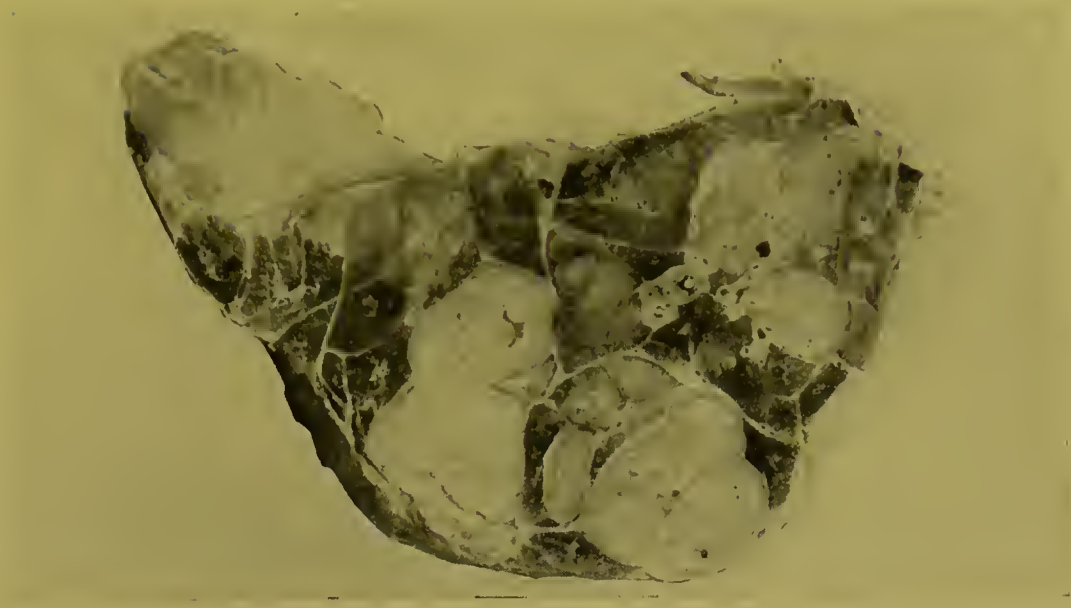


FIG. 10.—LUNG OF COW WITH LARGE TUBERCULOUS NODULES
Natural size. Tubercle bacilli present. (Preparation by S. Delépine.)

way into the tissue at one and the same time and become disseminated throughout any given area by means of the blood- or lymph-stream, an enormous number of these miliary tubercles will commence growing round the points of lodgment of the organisms at the same time.

They will all be at about the same stage at any given moment. As they increase in size they will get nearer and nearer together ; in time numbers of them will be found to coalesce, and in this way a large tuberculous mass is produced. The necrotic process above described is taking place simultaneously, and so the central portion of such a large area when cut into is found to be in a stage of caseation. There is almost no limit to the size of a tuberculous mass which may be produced in this way.

Local and General Tuberculosis. Should the primary infection produce a comparatively small tuberculous mass which remains restricted to that part, the tuberculosis is termed *local,* and the disease said to be *localised.* On the other hand, when the bacilli are disseminated through the circulation and the lymph-vessels, giving rise to immense numbers of tuberculous spots, the disease is said to be *generalised.* Primary lesions are principally found in the lungs, and the glands in connection with the lungs ; in the lymphatic glands in connection with the head ; in the intestinal tract and glands connected with it ; in the liver and portal gland ; or in the udder and organs of generation.

The longer the tuberculous process has been going on, in other words, the more chronic the case, the more are we likely to encounter large caseous or calcified masses ; calcification being a process which is common in all masses of dead tissue contained in a living body but especially so in tuberculosis. Sometimes a primary tuberculous area becomes encysted, and in this way the disease is cured naturally. In all animals one

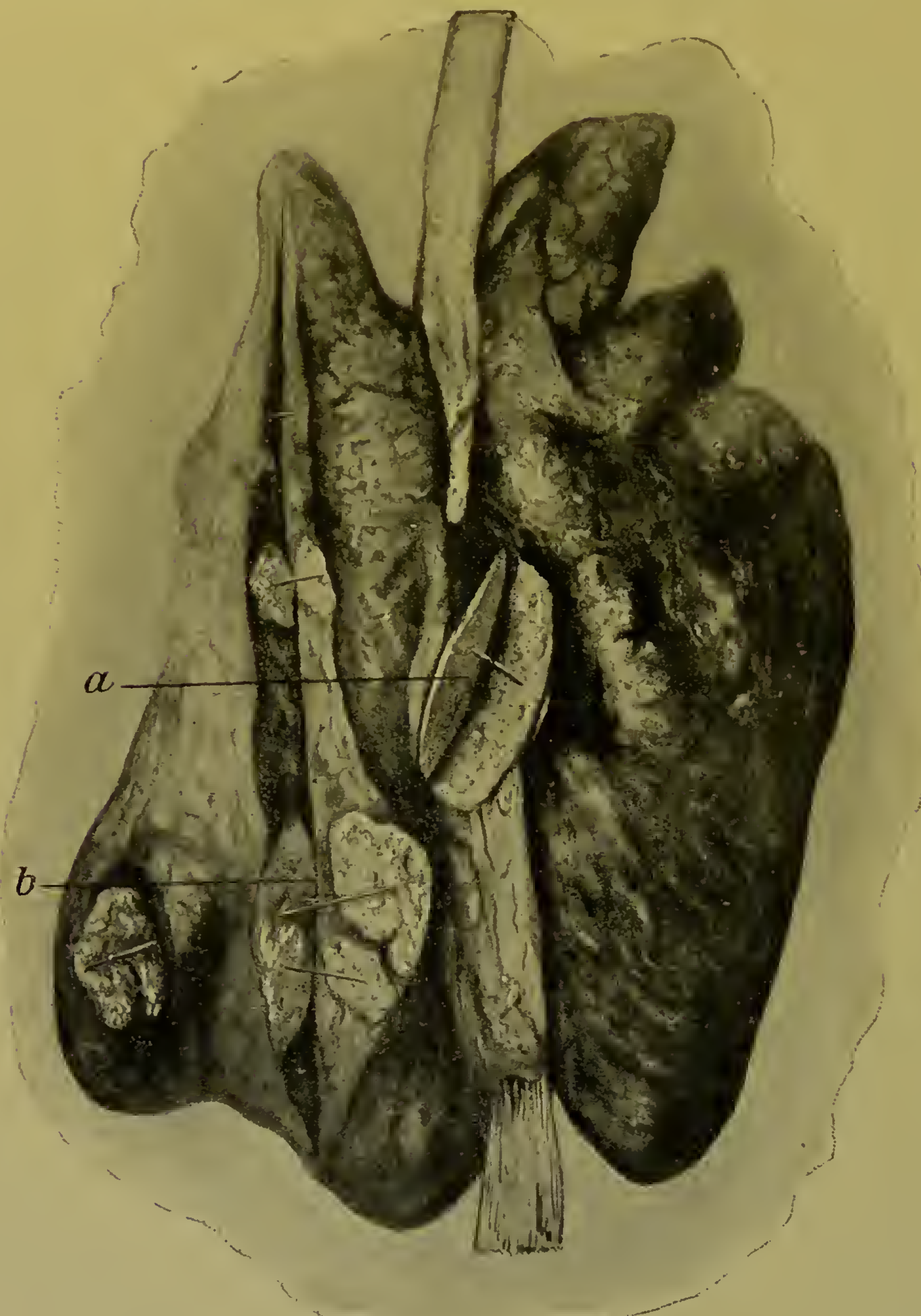


Fig. 11.—Bovine Pulmonary Tuberculosis

a. Incised gland. *b.* Tubercular mass in lung.

encounters many such instances of old attacks of tuberculosis which have never gone further than the local infection.

Finally, it is to be remembered that in those situations in which the tuberculous process is in contact with the exterior or connects with the outside air, there is always the possibility of putrefactive organisms becoming associated with the tuberculous process, producing a purulent result.

Occurrence of Tuberculosis in Swine. The disease in pigs is usually communicated by means of infected food, since such a large number of these animals derive their nourishment from the remains of dairy produce

or the organs of cattle which have been slaughtered, in which there is a considerable amount of tuberculosis. Tuberculosis in swine is very often generalised, the lesions consisting of numerous miliary tubercles which rapidly become caseated but are not so often calcified, as in cattle. These greyish areas are scattered in great numbers over the abdominal organs especially. Frequently the glands in the region of the head and neck are enlarged as the result of the infection, and inspection of these glands at the slaughterhouse should never be omitted (*see* p. 872).

Tuberculosis in Various Organs. In the relationship of various organs to tuberculosis great variation is found to exist in the relative frequency with which individual organs in the bodies of different animals suffer from the infection of tubercle, although this relationship is fairly constant in the same species of animal. The frequency of infection of

FIG. 12.—TUBERCULOSIS OF SMALL INTESTINE IN MESENTERIC GLANDS OF COW AND INTERNAL AND EXTERNAL APPEARANCE OF INTESTINES WITH TUBERCULOUS ULCERS

Tubercle bacilli abundant. (Preparation by S. Delépine.)

any given organ in any given animal depends upon the following factors. First, we have to consider the part played by the circulation of the blood in relation to the organ, especially with regard to the connection of the blood-supply with the seat of infection, and the rapidity of the circulation through that particular organ. Secondly, the anatomical relations of the organ to the parts around it frequently determine whether or not it is infected by direct continuity or extension of the tuberculous processes from the one to the other. Thirdly, there is not the slightest doubt that the secretions found in some organs of the body confer upon their organs a definite power of resistance to the action of tubercle bacilli as compared with other organs. Finally, the fact that in some cases certain tissues never, or very rarely, exhibit tuberculous lesions can only be explained by attributing to them an inherent immunity to the attack of this organism. As examples of these various agencies we find that the lungs, which receive immensely greater quantities of blood than any other organs in the body, as well as being directly continuous with the contents of the thoracic duct, invariably suffer in generalised tuberculosis, for the simple reason that the whole of the bacilli, which are thrown into the circulation from any source, pass through the pulmonary tissue. Given a subject, therefore, in which there is the slightest susceptibility to the action of these organisms, it is the lungs which are likely to suffer in the first place. Great numbers of bacilli become impacted in the minute capillaries of the lungs, thereby setting up tuberculous processes. A somewhat similar state of affairs occurs in the case of the liver, in those instances in which large quantities of tubercle bacilli are brought to that organ by the branches of the portal vein. It would appear that many such cases are restricted to the liver, the tissue of which, and especially the network of the capillaries, acts as a filter to the organisms preventing their further progress.

Percentage Infection of Organs. Many observations of a statistical character have been published showing the relative percentage of cases occurring in the different organs of the body. From these figures and observations Ostertag thus summarises the conclusions. He finds that in generalised tuberculosis in cattle there is a definite sequence in the order of attack of the different organs. There is a uniform infection of the lungs ; then follow spleen and kidneys ; and then the prescapular and inguinal glands, udder, bones, and joints.

When tuberculosis affects the posterior part of the peritoneum in female cattle the uterus is almost always attacked also. In the generalised disease in cattle up to four years of age, the spleen is almost always affected while the kidneys practically as often remain free ; whereas, on the contrary, in older cattle it is the kidneys which are affected, but not the spleen.

" In hogs, the lungs, liver, spleen, and kidneys are similarly affected in generalised tuberculosis. Furthermore, affections of the bones in hogs, especially the vertebræ column, are much more frequent than in cattle. Rieck, in four hundred and thirty cases of general tuberculosis

in cattle, identified at the abattoir in Leipsic, 1880–91, determined the following sequence in the affection of different organs :

" Lungs	100	per cent.
Liver	83	,,
Alimentary canal	73	,,
Serous membranes	57·4	,,
Kidney	52.5	,,
Meat	49·3	,,
Spleen	18.6	,,
Udder	16.7	,,
Bones	8.8	,,

" Moreover, Rieck found that 80 per cent. of the cases of tuberculosis

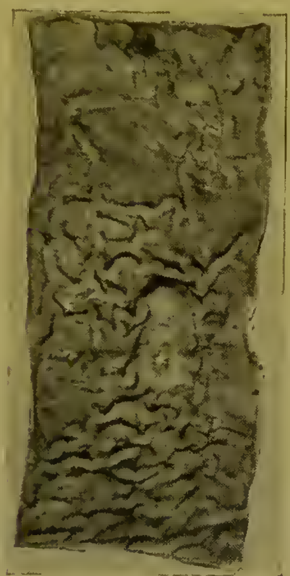


FIG. 13. — SMALL INTESTINE OF COW. SMALL TUBERCULOUS ULCERS

(Preparation by S. Delépine.)

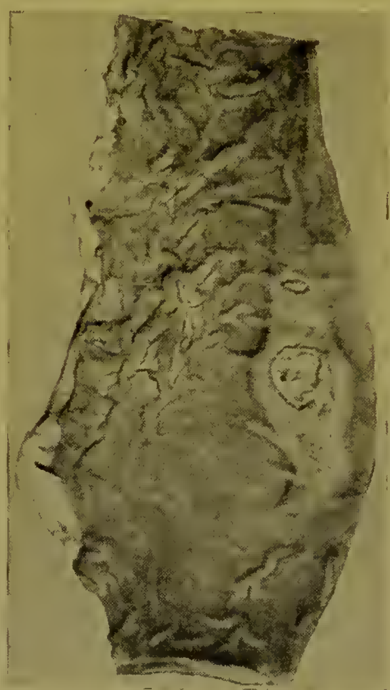


FIG. 14.—SMALL INTESTINE OF COW. SMALL TUBERCULOUS ULCERS

(Preparation by S. Delépine.)

were restricted to the lungs or bronchial glands. Several organs of one cavity of the body (usually the thoracic cavity) were affected in but 3.9 per cent. ; the process extended beyond the thoracic cavity in 1888 in 9.3 of the cases ; in 1889 in 13.3 ; in 1890 in 11.9 ; and in 1891 in 19.6 per cent. of the cases. In a considerable proportion of the last-named cases only the lungs and mesenteric glands were affected. Tuberculosis of the serous membranes was demonstrated in Leipsic in 10.8 per cent. of all tuberculous cattle (7.2 of male, and 14.8 of female animals) " (Ostertag).

Variations in Organs attacked. No doubt examination of a sufficient number of cases made from various slaughterhouses in different parts

of the world would give slightly varying figures from those quoted above. Thus we have ourselves found that the kidneys are comparatively rarely attacked, while the *covering of the spleen* almost invariably suffers in any widespread tuberculous infection of the peritoneal cavity. The tissue of the spleen itself, however, in these cases is commonly found to be perfectly free from the disease, which simply points to the fact that these cases are of the nature of a rapid lymphatic spread throughout the whole abdominal cavity, and not caused by means of systemic blood-stream infection. Similarly in such cases it is quite common to find the surface of the liver thickly coated with tuberculous processes, while the section through that organ will often show the liver tissue to be healthy. In our experience also it is far more common to find an extensive tuberculosis in the prescapular gland in cases of pulmonary disease than it is to find any lesion in the bones or joints. We would remind inspectors that an accurate impression of the relative order of attack in these situations can only be obtained where it is made the routine practice to examine this and other glands in every case of the disease. Quite commonly it will be found in advanced thoracic tuberculosis that the prescapular gland on the one side will be affected while that on the other side is not.

Tuberculosis of Muscle. Infection of the muscles themselves—the meat of the carcases, that is—is an extremely rare occurrence. Occasionally the inspector will encounter superficial deposits of tuberculosis *on* the muscles, and these may be of an extensive character. They, however, do not penetrate deeply, being confined to the connective tissue covering of the muscles themselves. These deposits are merely examples of the direct continuity of the process by means of lymphatics. It is extremely rare to find an actual tuberculous area in amongst the muscle tissue itself. This remarkable fact raises the immensely important question of the justification which exists for a wholesale condemnation of meat in carcases which show signs of tubercle.

Do we condemn too much ? We are amongst those who believe that an immense quantity of meat, which is perfectly safe and fit for human consumption, is condemned every day unnecessarily, but at the same time it is to be carefully borne in mind that there are questions besides that of the risk of actual infection which have to be taken into consideration by the inspector. This applies not only to tuberculosis but to many other diseases. The question is too frequently asked, "Is there any risk of contracting the disease from eating this meat ?" The answer to that question in very many cases is "No"; and it is thereby assumed by some that the meat ought therefore to be passed as fit for food. It does not by any means follow. The infection of specific disease is not the only thing which has to be considered. There arises also the further very important question as to the nutritive and health-giving properties of the meat itself, as well as the question of the risk of setting up gastric and other troubles from eating it. It is quite possible, and it constantly happens, that a person may eat meat without

being infected with any particular disease, but may, at the same time, suffer in many indirect ways from the toxic properties of that meat. So in tuberculosis it must be remembered that even though there be no actual tuberculous deposits in the muscular tissue itself, nevertheless that muscle has been nourished by secretions which are themselves the product of the blood of an animal which is more or less saturated with tuberculosis toxins. The ultimate judgment of the inspector in these cases must be dependent upon the local or general regulations laid down for him, and in doubtful cases by his own common sense and experience in this and other diseases.

Judgment by Serous Membranes. Ostertag goes so far as to say that the condition of *the serous membranes should play a very subordinate part in the judgment* of the inspector as to fitness or otherwise for human food of the meat of tuberculous cattle. It is, of course, quite true that the tuberculous lesions found in the peritoneum and the pleura are often quite local in character, and frequently the process spreads directly from the former to the latter by continuity of their lymph-vessels. Further, the disease may occur in the peritoneum as the result of the animal swallowing some of its own bronchial secretion in which there are bacilli derived from a local tuberculous area in the lung, the result being most frequently an infection of the mesenteric glands. He points out, with which every meat inspector will agree, that a very extensive tuberculosis may occur upon the peritoneum and the pleura, while at the same time the actual tissue of the lungs, liver, spleen, and other organs may be perfectly healthy.

On the other hand, in an extensive generalised tuberculosis, or in an acute miliary disease, these organs and others may be seriously affected while the serous membranes may escape altogether.

Judgment by Mesenteric Glands. This same author considers that the importance of judging meat according to the condition of the mesenteric glands is largely exaggerated, since these glands are frequently infected by the animal itself in the manner above stated. Ostertag, therefore, recognised that the examination of tubercular animals should begin with these organs which are presumed to be healthy, not with those which are known to be diseased ; because the inspector is thereby less liable to contaminate healthy organs from his knife or hands which have been in contact with the diseased tissues. Should he proceed in the opposite manner it is a very simple matter to convey by means of the knife tuberculous material from, for example, the lungs which were diseased, to the liver which may have been quite healthy ; and the latter may then be exposed for sale with this technical fault committed.

Cutting the Carcase Unnecessarily. It may be here pointed out to the inspector that in all those cases where the disease is undoubted, there should be as little cutting of the tuberculous parts as possible, unless it is necessary for purposes of demonstration or teaching. In other cases the inspector should use his eyes more than his knife, and the latter only when the evidence is doubtful. Such considerations, however, apply

with much greater force to continental countries where precautions are taken for the careful sterilisation of meat from infected carcases before it is sold, than to this country, where in case of anything like extensive disease the whole carcase is usually condemned. As a matter of fact, it will be certainly true to say that, as far as Great Britain is concerned, the tuberculous infection of the serous membranes plays anything but

FIG. 15.—BOVINE TUBERCULOSIS
Enlarged caseating mesenteric gland incised. (Leighton.)

a subordinate part in the judgment of the inspector, being in fact, perhaps, that to which he attaches the greatest importance.

TUBERCULOSIS IN PIGS

Having dealt with tuberculosis generally from the point of view of cattle, we must next direct out attention to the disease as it occurs in swine, where it is of no less importance, as far as meat inspection is concerned, than in cattle ; indeed in some aspects it is of even greater importance, on account of the peculiarities, pathological and otherwise,

which are found in these animals. It is not very easy, at the present moment, to come to a definite conclusion as to whether tuberculosis in swine is becoming more common or less common. All inferences leading to one or other of these conclusions must necessarily be drawn from the statistics which are available in the reports of the number of carcases condemned in all the various slaughterhouses, abattoirs, &c., in different parts of the world where an organised system of meat inspection is in operation, and so far as our own country is concerned such statistics have not been available over a sufficiently large number of years to enable one with any certainty to judge upon the matter.

Increasing in Frequency. In some other countries, however, in which statistical records have been kept for a longer period and with greater accuracy, it may be possible to form an opinion on the point. Thus Mr. J. R. Mohler and Mr. H. J. Washburn, in their article on the subject in the Report of the Bureau on Animal Industry from America (1907), say that, although there is a decrease in the number of swine sent to market reported to be tuberculous, there is at the same time an increase in the number of swine affected, which simply means that greater care has been taken in eliminating the tubercular animals before they were sent to the slaughterhouse. They, however, add that in that country there is no disease, not even excepting swine fever, which causes heavier loss to the pig-breeder than tuberculosis, a loss which also falls upon the meat-packers and causes great anxiety to the veterinary inspectors. The authorities above referred to estimate the prevalence of tuberculosis at almost 1.5 per cent. of all pigs slaughtered at the abattoirs of the country which have inspection. Although that percentage represents an enormous number of animals considering that the swine were estimated at 56,084,000 in 1908, it is not nearly such a high figure as that in some European countries, which would indicate that tuberculosis is more common than in America, some of the European figures giving a percentage of 5.5 to 7.5 per cent. (*see also* Vol. V., New Zealand).

Relation of Bovine to Swine Tuberculosis. It is not surprising to find that where investigations have been made on the point there has frequently been established a very close connection between the occurrence of tuberculosis in cattle and the disease in swine. It is, of course, a usual thing for the same owner to possess both kinds of animals, and in the case of an infectious disease to which both species are liable it would be strange indeed if such a connection were not found. In some of the States of America where this matter has received considerable attention, the veterinary inspector, on receiving information that some pigs have been found on a certain farm suffering from tuberculosis, is empowered to quarantine that farm and apply the tuberculin test to any cattle thereon ; and the result of this has been that in many cases cattle have been found to be tuberculous. It was also found that successive shipments of pigs by certain farmers always contained a certain proportion of tubercular cases, and in this way the source of infection in many cases was traced to its origin and dealt with there.

FIG. 16.—TUBERCULOSIS OF GLANDS (LYMPHATIC) IN PIG'S HEAD
(From Dr. Hope's Collection.)

The Condition in Paris and in Dairy Countries. According to reports of the veterinary inspectors of the abattoirs in Paris, there seemed to be comparatively few cases of tuberculosis in pigs in the abattoirs there; and apparently the disease is not a source of any considerable loss to breeders of swine in France. The French authorities themselves account for this interesting fact by saying that the highest proportion of cases of tuberculosis in pigs is always to be found in those countries in which the dairy produce from cattle has been developed to such an extent as to be the principal agricultural interest. In other words, in those countries in which the cattle have been bred for generations with a view of providing the most remunerative type of animal for the production of milk, butter, cream and so forth, there also will be found the greatest susceptibility to tubercular infection, and obviously also the greater number of opportunities for transmitting that infection from the cattle to the pigs. In support of this explanation they point to the fact that in the year 1897 the percentage of tuberculosis in pigs in Copenhagen was 15 per cent., and in Douzig (Denmark) it was as high as 70 per cent., in both places the principal food of the pigs being the products of the dairy.

The Condition in Germany. Certain reports from German sources would seem to indicate that tuberculosis of pigs, as well as of cattle, is becoming more common in that country. For instance, the percentage of swine found to be tubercular in Berlin in the years 1883–84 was .53, whilst by 1897–98 the percentage was 3.9, and still later reached the figure of 5.79; and this in spite of the fact that only those animals which appear externally quite healthy are permitted to enter the Berlin abattoir.

Swine Tuberculosis in Great Britain. In Great Britain we find considerable variation in the percentage occurrence of tuberculosis in pigs in different localities as far as this occurrence can be estimated from the returns available. Thus in one report from Birkenhead it was found that there were 207 tubercular pigs out of a total of 22,852 slaughtered, giving a proportion of nearly 1 per cent. In another return from the London Corporation Abattoir at Islington seventy-five pigs were found infected out of a total of 15,225, or about .5 per cent. A return of those slaughtered in Glasgow, on the other hand, showed that no fewer than 2553 pigs were found tubercular out of a total of 60,235, or 4.24 per cent. Too much stress need not be laid upon figures such as these taken from special reports, except so far as to illustrate the point above mentioned, namely, that the occurrence and proportion of the cases of tuberculosis in pigs in this country vary considerably in different localities.

In Holland and New Zealand. On examination by the meat inspectors of a total of 368,428 pigs in Holland which were to be imported into this country, 5516 were found to be diseased, a percentage of 1.5.

In the report for the year 1907 on meat inspection in New Zealand it was stated that as many as 5.89 per cent. of those examined were found to be affected with tuberculosis.

Path of Invasion. As the result of many experiments which have been made in different countries, and of an examination of the clinical and other evidence obtained by many veterinarians, there can be no doubt whatever that the common path by which the organisms of tuberculosis enter the pig is that of the commencement of the alimentary tract.

Messrs. Mohler and Washburn, in America, and others also, have found the bacilli on the tonsils in apparently normal animals, and from that point to the nearest glands is a very short journey. It is a suggestive discovery in the light of the fact that in all cases of tuberculosis in pigs *no less than 93 per cent. are found to affect the submaxillary gland,* from which spot to the tonsils there is a direct lymphatic connection. Moreover, the feeding propensities in swine render them particularly liable to take into their mouths tubercular infection from all sorts of sources; and not only the infection, but materials along with it of a nature readily to cause slight abrasion in the mucous membrane of the alimentary tract, which would afford a point of entrance for the bacillus into the system. It is suggested that young pigs at the time of teething are liable to be infected owing to abrasions of the mucous membrane arising from the new teeth (Mohler and Washburn).

Occasionally it happens, but not very often, that the only evidence of tuberculosis in the pig is found in the mesenteric glands. In these cases it would appear that the bacilli have escaped absorption on the way down the alimentary tract until they were taken up by the lymphatic vessels of the intestine. It is more common, however, to find tuberculosis affecting the bronchial glands and the gastro-hepatic glands than the mesenteric alone, and these especially in association with the submaxillary gland. Direct infection by means of the lungs is not at all common in pigs.

Methods of Infection. The anatomical considerations above noted point conclusively to the method of infection being along the path of the alimentary tract, and suggest a close association with the occurrence of the disease in cattle, as has already been pointed out. In many cases where there has been a sudden increase of the number of tubercular swine, investigation has shown that the affected pigs have been fed upon the products of an infected dairy, or even upon the carcases of cattle which have been destroyed.

We would lay special stress upon this point, as has also been done by some observers on milk, in order that those whose duty it is to trace out and endeavour to eliminate the source of contamination in this disease may have their attention directed to the common association of tuberculosis in cattle and its subsequent appearance in the pigs on the same farm or in the same locality. There are, of course, other methods of infection, of which we may mention direct infection of the litter from a tubercular sow. But this, and any other source of tuberculosis in pigs, is probably of very little importance when compared with the question of the infection of the pigs by means of either the milk or the excreta of tubercular cattle.

FIG. 17.—PIG'S PLUCK—HEART, LUNGS, AND LIVER Tuberculosis. (Dr. Hope's Collection.)

Cattle and Pigs to be dealt with Simultaneously. It is not too much to say that the extermination of the disease and its elimination in pigs will proceed just as quickly or just as slowly as does the extermination or elimination of tubercular cattle. Experiments in almost all civilised countries have been made in this connection, and all show how easy it is for the pig to contract tuberculosis when fed upon milk from a tubercular source. In some of the experiments the result has been that every pig so fed contracted tuberculosis. A considerable number of cases have been traced to the feeding of pigs from the refuse of modern creameries, but there can be no doubt that a very common source of infection also is from the fæces of tuberculous cattle, where the cattle and the pigs are together. It has been shown in recent years, both in this country and in others, that the excreta of tubercular cattle frequently contain large numbers of bacilli, and experiments on the virulence of this mode of inspection have shown that the pig contracts the disease as readily in this way as in any other.

Condemned Carcases should be destroyed. Still another source of infection, and one which ought not to be permitted, is the feeding of pigs on carcases or offal which have been rejected at the slaughterhouse or other places of killing. Where regulations exist for the destruction of condemned carcases this source of infection will not operate.

Infection from Man. Lastly, we may mention in this connection that tuberculosis may be caused in swine as the result of infection from human cases. Professor Bang has recorded an outbreak of tuberculosis amongst pigs in an hitherto disease-free farm, in which infection was directly traced to attendants who were suffering from tuberculosis, and had no doubt contaminated the food from their sputum. Most observers agree that pigs are susceptible to infection from both bovine and human sources, and the British Royal Commission on Tuberculosis comes to the conclusion that the resisting power of pigs to the human bacillus is less than that of cattle.

The Condition of Pigs with Tuberculosis. We have already drawn attention to the fact that bovine tuberculosis is frequently unsuspected until the carcase is inspected at the slaughterhouse, and it is equally true that there are usually no outward symptoms in pigs which are affected in the same way. Just as in cattle, it often happens that those animals which appear to be in the very best condition externally, when seen before slaughter, are, on post-mortem examination, discovered to be the tubercular ones. In those few cases in which the external symptoms are obvious these symptoms are such that might readily be associated with other diseases also. In advanced generalised cases there is, or may be, considerable digestive disturbance, and in severe pulmonary cases there are a persistent cough and rapid breathing, and there may be also progressive emaciation and general weakness. All these symptoms are the exception, and as a rule the pig is considered to be healthy until inspection of the carcase demonstrates the tubercular lesions.

Moreover, in pigs which exhibit no external signs whatever of the

disease the latter may be found on post-mortem examination to be so widely diffused throughout the different parts of the carcase as to cause the whole to be condemned as unfit for food.

Tubercular Lesions in Swine. In endeavouring to account for the rapidity and ease with which tuberculosis becomes generalised in these animals, one naturally searches for some environmental condition which would render them specially susceptible to such a result ; and possibly this may be found in the fact that pigs are fattened so rapidly during the first year of their lives in order to bring them in the quickest possible time to a marketable condition. This can only be done by interfering very considerably with what one must regard as the normal physiological growth and development of the animal, and it is quite likely that this rapid artificial stimulation of growth and fattening carries with it a lessened power of resistance or an increased susceptibility to infections in general, and of that of tuberculosis in particular. However this may be, the lesions which are found on examination occur in distinctly separate parts of the body and commonly appear to be of a somewhat chronic nature, as exhibited by the amount of calcification or calcareous deposit which has taken place in the tubercular areas, and also by the proliferation of the connective tissue elements in the same parts.

Usually the lymph-glands throughout the whole body are found affected, or at any rate lymph-glands in different parts of the body. McFadyean has reported widespread tuberculosis in pigs from eight to ten weeks old in which calcification had already appeared in the lesions, and the same observer has also placed on record the occurrence of generalised tuberculosis in pigs from six to eight weeks old.

The morbid anatomy of the lesions is of the same type in pigs as in other animals, the usual nodules being formed ; and, as in other animals, these run together as the disease progresses, thus forming larger areas. The cellular elements are those of epithelium, lymphatic and connective tissue, as in other animals, and giant cells may be found.

The caseation, as usual, commences in the centre of the nodule, but many of these tubercular areas become so rapidly fibrous or calcified that the caseation process is not so obvious. This is a point to which meat inspectors would do well to pay attention, as it does not always receive the recognition it deserves. Another form of lesion occurs in the lymphatic glands, in which the capsule of the gland and the fibrous stroma undergo a very marked overgrowth and proliferation, with the result that the lymphatic cells themselves correspondingly disappear and degenerate. Commonly, however, as the gland enlarges, the yellowish area of commencing caseation can be seen at different points surrounded by an area of congestion, rapidly becoming gritty from calcification.

As we should expect from the conclusion that the principal mode of infection is by ingestion, it is in the glands associated with the alimentary tract that the lesions are principally seen.

Common Positions. We have already stated that the proportion of cases in which the submaxillary gland is affected is no less than 93 per

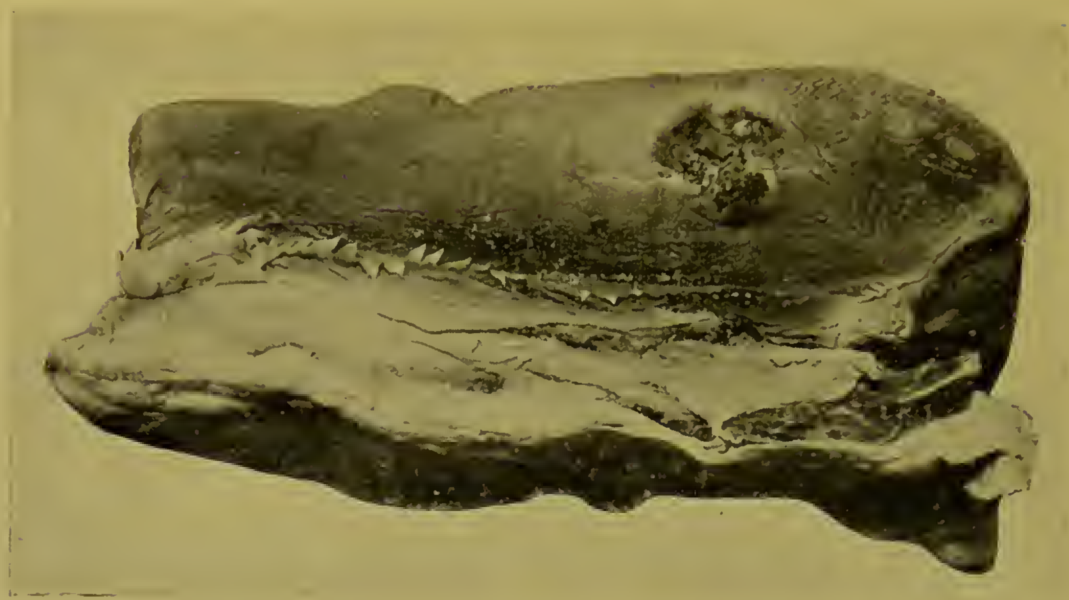


FIG. 18.—TONGUE OF PIG WITH TUBERCULOUS ULCER
(Preparation by S. Delépine.)

cent., and it is this fact which is the justification of the meat inspector in his routine examination, in the course of which he invariably examines this gland first. Next in frequency, possibly, are the bronchial glands, which are found to be diseased in about 27 per cent. of cases, and following them the gastro-hepatic glands, which are involved in about 21 per cent. Such, at any rate, is the conclusion come to by American inspectors over a series of examinations on 120,000 tubercular carcases of pigs.

In addition to these, the mesenteric glands show the disease in 18 per cent. of cases, the liver was affected in 9 per cent., and the lungs in 7 per cent. in this same series. The spleen exhibited lesions in only 3 per cent. of cases, and in this organ the appearances of tuberculosis are in striking contrast to those which were found to occur in cattle. In the bovine type the lesions are usually confined to the serous covering of the spleen, and are rarely in the substance of the organ. In pigs, however, the surface of the spleen shows a dark colour and a number of nodules of various sizes, which, however, are found on section to be associated not merely with the covering, but with the actual structure of the organ. In many of these nodules there is a radiating arrangement of fibrous tissue from the central portion, the appearance of which can be seen in one of our illustrations. The lesions in the liver may be either yellowish points scattered throughout the organ, as well as upon the surface, or they may be large irregular nodules, either fibrous or calcified.

In the lungs the appearance is that of miliary tuberculosis, together with tubercular broncho-pneumonia. The lungs present a very different appearance to that usually seen in the bovine disease (Plate XVI.).

The mediastinal glands were affected in one analysis in 1.8 per cent. of cases, while the serous membranes showed an occurrence of only .1 per cent. on the pleura and .006 on the peritoneum, a most striking con-

trast with what we noted in cattle. The bones of the vertebræ and other situations are occasionally attacked, and the disease has been recorded in the muscles, where the lesions are those either of small separate nodules in a fibrous capsule or a number of small tubercles with early calcification.

It is extremely rare to find evidence of tuberculosis in the kidneys in swine.

Comparison with Cattle. It may be useful to the inspector briefly to summarise the more important differences between the lesions of tuberculosis in pigs and cattle. In pigs the submaxillary glands are the most common site, but in cattle they are rarely affected. The lungs are less commonly attacked in pigs than in cattle, and when they are attacked it is usually in a secondary manner, not primarily. The pleura and the peritoneum are seldom the seat of disease in pigs as compared with cattle. These serous membranes

FIG. 19.—SPLEEN OF PIG
Tuberculosis (tubercle bacilli present).
(Preparation by S. Delépine.)

FIG. 20.—SPLEEN OF PIG
Advanced tuberculosis, with tuberculous masses in gastro-splenic omentum.

rarely present grape-like lesions. Both the liver and spleen, particularly the spleen, are more commonly affected in pigs than in cattle. The mammary gland is more commonly tubercular in cattle than in pigs. Bones, joints, and muscles are more affected in pigs than in cattle, showing the more thoroughly generalised condition of the disease.

FIG. 21.—RIBS OF PIG

Tuberculosis of the vertebral end of the rib. (Preparation by S. Delépine.)

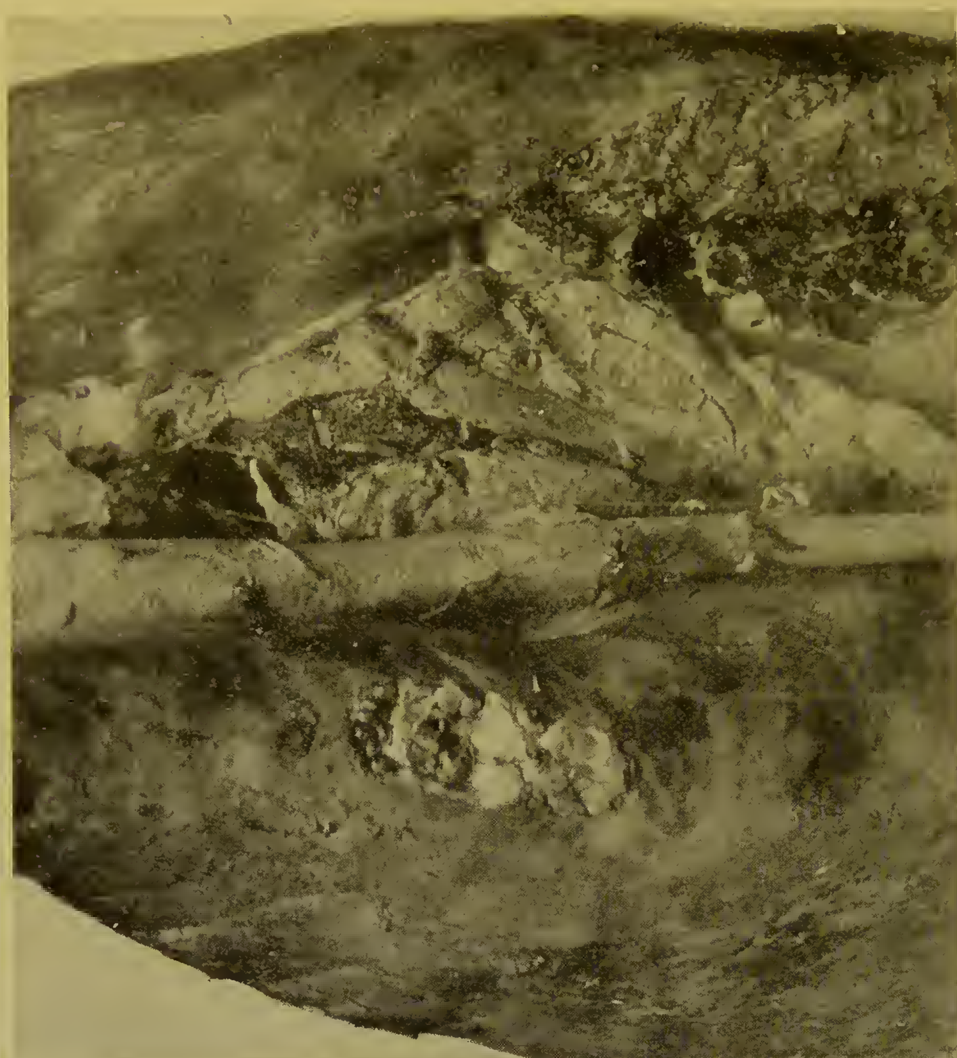


FIG. 22.—BOVINE PULMONARY TUBERCULOSIS

The pleural surface is comparatively free from tubercle, but where the lung-tissue has been exposed it is seen to be badly affected. A blood-stream infection. (Leighton.)

TUBERCULOUS LUNGS OF HOG

The morbid anatomy of tuberculosis in the lungs of swine simulates that observed in human tuberculosis more than in bovine tuberculosis. The disease has many points of similarity to human infantile tubercle. Not infrequently there are observed large numbers of miliary, grey, or translucent foci, showing evidence of generalisation as a result of the tubercle bacilli being disseminated by the blood-stream. This condition is here depicted in a plate kindly lent by Dr. Melvin, from the 24th Annual Report of the Bureau of Animal Industry, Department of Agriculture, Washington, U.S.A.

The lymphatic glands situated in the remote parts of the carcase are more commonly affected in pigs than in cattle.

The mediastinal glands, however, are less commonly affected in pigs. A considerable number of cases in pigs exhibit the disease in two or three groups of glands which show no evidence of having any connection with each other, as far as the spread of the disease is concerned. The huge masses of tubercular lesions on the peritoneum in cattle are rarely seen in pigs. When such do occur, they are generally found to exist in connection with an adjacent or contiguous organ which is in an advanced stage of the disease. Lastly, in this connection, it is but seldom that the meat inspector encounters tuberculosis in cattle during the first year of their life. It is precisely during this first year that most cases in pigs are seen. This is due to the fact that, as far as the pigs are concerned, most of them are slaughtered during the first year of their lives, and contract the disease from tubercular food.

Consideration of Special Lesions and Cases. We may now further exemplify the general facts above considered by recording and illustrating a few typical cases of tuberculosis from our own recent experience—cases which are typical of those encountered daily by the meat inspector.

Bovine Pulmonary Tuberculosis. In the illustrations (Fig. 22 *et seq.*), which are from photographs of a condemned carcase at the Edinburgh slaughterhouse, we have an excellent example of a form of bovine tuberculosis which frequently comes under the notice of the inspector. Because it is frequent it is important. In Fig. 22 are seen the lungs, together with some of the bronchial and mediastinal glands. These have been cut open so as to display more clearly the process of caseation, which is well seen in the large gland lying midway between the two lungs. It will be observed that the surfaces of the two lungs are perfectly smooth, except at one point at the bottom of the photograph, where the lung has been cut into. In other words, there is no tubercular deposit or growth on the pleura, but the tubercular areas can be distinctly seen in places showing through the pleura, and where it is incised. The whole of the lung-tissue is seen to be riddled with the disease. This means that the path of infection in the lungs has been by means of the blood-stream, not by means of the lymphatics, since in this latter case the nodules would have been upon the surface of the pleura. True the lymphatic glands are badly affected, as can be seen ; but these too have received the infection through their blood-supply. So much could have been deduced merely by an external examination of the specimen of the lungs. But it so happens that the writer had also the opportunity of seeing the carcase, in which there was no evidence of tuberculosis on the walls of the thorax, though ample on those of the abdominal cavity

The source of the disease in this particular case was very obvious when the abdomen and the organs contained in it were examined. There was an extensive and comparatively recent tubercular peritonitis, which

had resulted in a tubercular deposit on the surfaces of the liver (as shown in Fig. 23), where the roughening on the surface due to the organisation of lymph containing tubercular elements is very well seen. The disease, however, is confined to the surface, so that here it was a local inflammatory or lymphatic infection. The condition of the mesenteric glands, however, afforded ample evidence of the original site of the disease. These were all immensely enlarged, some of them to the size of one's fist or more, and all when cut into showing a very advanced stage of caseation and grittiness. Two such glands from this case are shown in the photograph (Fig. 24) cut into, in which illustration the size of the glands can be well estimated by the loops of the intestines. A series of these glands is illustrated in colour in Plate XVII. This series of illustrations gives a very good idea of a very common series of events which occur in the cow when tuberculosis starts, as it so often does, as an alimentary infection, where the most advanced lesions are found in the glands in the abdomen, and where, sooner or later, a number of bacilli are thrown into the lymph-stream and, passing by means of the thoracic duct through the heart to the lungs, produce the condition seen and described above.

Fig. 23.—A Very Common Type of Bovine Tuberculosis affecting the Liver on the Serous Surface

A lymphatic spread. (Leighton.)

Fig. 27 is a photograph of the same lungs somewhat enlarged, showing the condition in greater detail.

Bovine Tuberculosis of Head and Neck. Meat inspectors in this country, as a rule, make no inspection particularly directed to ascertaining the presence or absence of disease in the head and neck, simply because the head, along with the tongue, is seized as a routine procedure in those cases where the carcase is condemned for thoracic tuberculosis. On the Continent, however, the inspector examines the

glands at the root of the tongue and under it in every case, as described in our discussion on methods of inspection (*see* p. 792). Fig. 25 shows a head in which the submaxillary glands were badly affected, being greatly enlarged and in an advanced stage of caseation. The specimen was the head of the same animal from which Figs. 23 and 24 are taken. A still better example of tuberculosis of the glands in this situation is seen in Fig. 1, p. 983, which is from Professor Delépine's collection.

FIG. 24.—BOVINE TUBERCULAR PERITONITIS, WITH ENTERITIS

Note the tubercular organised deposit on the intestines. Two greatly enlarged and caseous mesenteric glands are exposed and incised. (Leighton.)

Tuberculosis of the Spleen. As we have pointed out elsewhere, the substance of the spleen usually escapes in cattle, the tubercular process being commonly limited to the peritoneal covering of the organ, where it shares in the general abdominal peritonitis. Thus, the common condition is seen in Fig. 26, which is the spleen from the same case as the lungs and liver seen in Figs. 22 and 23. The roughened surface is simply the deposit of inflammatory lymph which has organised and subsequently developed tubercular nodules or follicles from the presence

FIG. 25.—BOVINE TUBERCULOSIS

A bovine skull suspended by the tongue, to show the advanced caseated glands at the back of the throat. (Leighton.)

FIG. 26.—BOVINE TUBERCULOSIS

Spleen showing extensive deposit on the peritoneal surface, the usual lesion of the spleen. (Leighton.)

of the tubercle bacilli in the effusion. The condition is precisely similar to that described in the liver and seen in Fig. 23.

Nodular Pulmonary Tuberculosis. On cutting through the substance of a lung such as that seen in Fig. 27, one finds that the tubercular process is very evident, especially in certain parts. In some cases the whole lung is uniformly affected, hardly a lobule escaping, but more commonly

Fig. 27.—Bovine Pulmonary Tuberculosis

Disseminated over surface (lower right side of photo) and through the substance of the lung. (Leighton.)

the caseating nodules are more numerous and more thickly aggregated together in certain areas. This is seen to be the case in the lung represented in Fig. 27, which, as a matter of fact, is the same lung as is seen from the outside in Fig. 22; the tubercular disease is hardly seen in the anterior part, but in the middle and posterior portions is very advanced. This partial distribution is quite a common occurrence, and depends upon the distribution of the blood-vessels, by means of which the bacilli were scattered through the pulmonary tissue. Despite the

advanced condition of the lung itself, the pleura remains unaffected as yet, though in such a case as this the parietal and visceral pleura would soon have become affected from lymphatic continuity with the abdomen had the animal lived sufficiently long.

BOVINE TUBERCULOSIS

A portion of the intestines, showing two much-enlarged tubercular glands, cut open. Caseous and calcified areas.

CHAPTER VIII

MEAT AS A SOURCE OF INFECTION IN TUBERCULOSIS *

The following excellent summary of this part of the subject, especially from the point of view of the medical officer of health, is quoted, by permission, and is from the pen of Dr. Arthur Littlejohn, D.P.H.

What is meant by the term "meat"? As used in this chapter the term includes not only the flesh but all parts of the animal body that are utilised for human food. Most parts of the animal body are used for human food, for amongst the poor the liver, lungs, udder, and mesentery are eaten.

What "Food Animals" are Affected with Tuberculosis? All our "food animals" are liable to infection. About 20 to 30 per cent. of our cattle are to some extent tuberculous. Young cattle up to one year old are rarely affected (about .05 per cent.) but the percentage increases with each year of life, and, in old milch cows, ten to fifteen years old, it may reach 75 per cent.

About 4 to 5 per cent. of our pigs are tuberculous. Seeing that in pigs tuberculosis tends to generalise so rapidly, they are quite as serious a source of danger to man as cattle, although a smaller percentage are affected.

It is difficult to give even a rough estimate of the percentage of cases of tuberculosis in fowls, but the disease occasionally becomes a plague, for the stamping out of which destruction of both fowls and buildings is necessary.

Other domesticated birds, turkeys, ducks, and confined pheasants are occasionally affected. Avian tuberculosis is, no doubt, the same disease as mammalian tuberculosis, but elaborate methods (viz., repeated passage through animals) are necessary in order to infect fowls with human tuberculosis.

According to Nocard, avian tuberculosis is not transmissible to man.

Sheep and goats are rarely affected (about .002 per cent.). Rabbits are very susceptible to experimental infection, but are rarely attacked naturally, even when kept in confinement.

Horses in this country are not much used for human food, and in them tuberculosis only occurs in about 1 per cent.

It will thus be seen that cattle and pigs are the only "food animals" in the consumption of whose flesh there is any serious danger of tuberculosis being transmitted to man. It is not surprising, therefore, that

* Read before the National Tuberculosis Conference in London. By Arthur R. Littlejohn, M.R.C.S., D.P.H. (Published in *The Practitioner*.)

most of the investigations concerning tuberculosis from eating meat have been made on cattle and pigs.

Can Man contract Bovine Tuberculosis? Von Behring, in his Cassel Lecture, 1905, stated that he believed that the source of infection with tuberculosis in adult human beings was an infantile contraction of bovine tuberculosis through feeding children on milk, and that the tuberculosis remained latent until restarted in adult life.

Ravenel, in 1905, pointed out that the bovine tubercle bacilli had a much greater virulence on other animals than had human tubercle bacilli, and he argued that it would be remarkable, seeing how susceptible man is to tuberculosis, if he were immune to the more powerful virus.

Koch, in his Nobel Lecture, 1906, stated that he believed that bovine tuberculosis was not transmissible to man, but qualified his statement by saying that, at any rate, generalised tuberculosis, and, above all, pulmonary tuberculosis of man was never the result of transmission of bovine tuberculosis.

The generally accepted view now is that human tuberculosis may be and is caused by bacilli of either bovine or human origin.

The Royal Commission, in its second interim report, 1907, confirmed the conclusions come to by various individual investigators that there is a bovine and a human type of tubercle bacillus, and that these are distinct and recognisable.

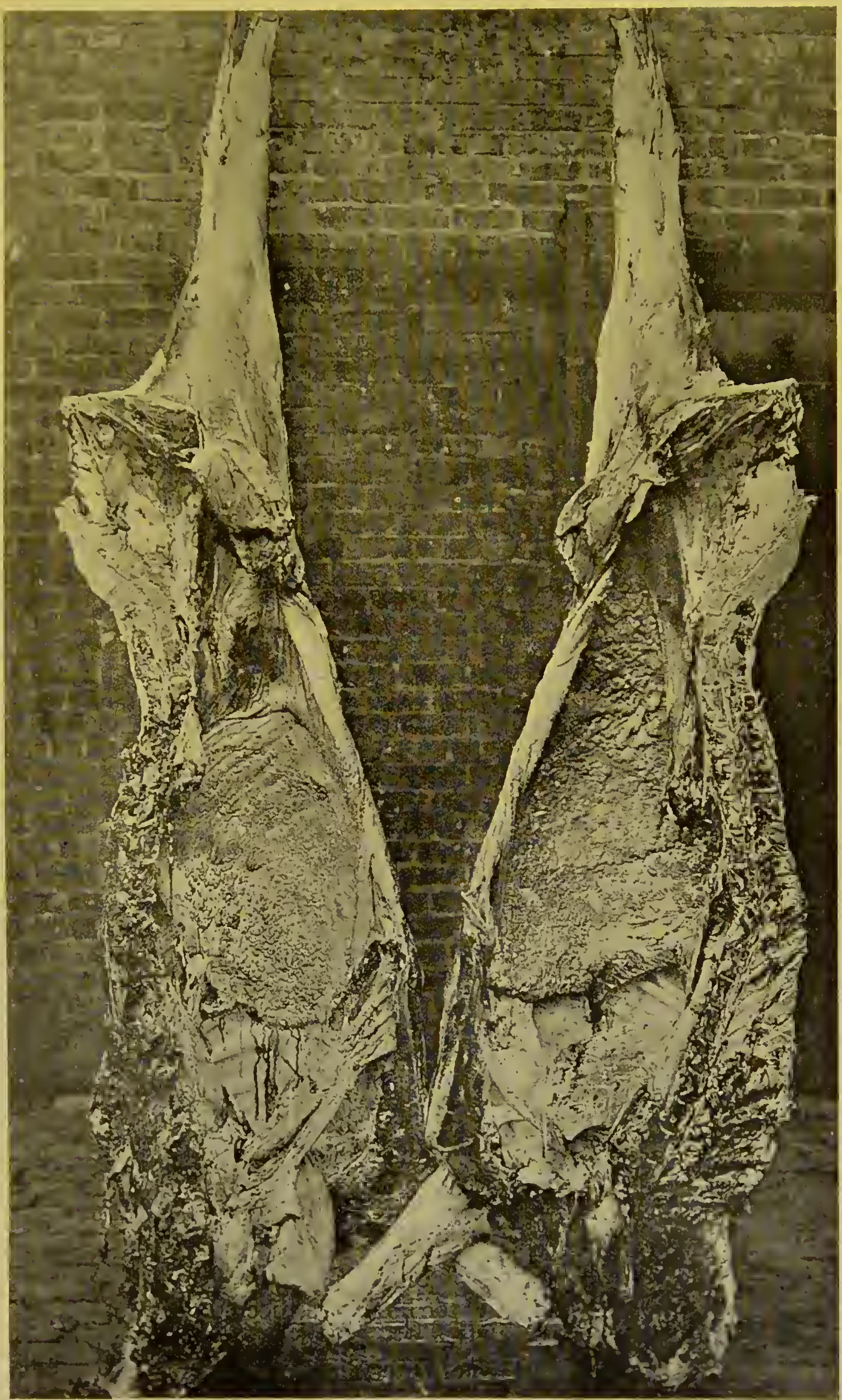
Theobald Smith had previously (1898) obtained two types of tubercle bacilli from the mesenteric glands of children, one type of which conformed to the distinctive tests of bovine tubercle bacilli. In a later paper (1905) he also quotes other authorities who had obtained the bovine type from man.

The Imperial Board of Health in Berlin, under Kossel (1905), records finding bacilli of the bovine type six times in fifty-six cases of human tuberculosis. These results were, with one exception, obtained from the mesenteric glands, or intestinal ulcers of children. The sputum of tuberculous adults, however, invariably contained the human type only.

The Royal Commission, in its second interim report, 1907, found that ten out of nineteen cases of primary abdominal tuberculosis, three out of eight cases of tuberculous cervical glands, one out of four cases of tuberculous lungs in human beings, were due to bacilli of the bovine type.

Primary tuberculosis of mesenteric and cervical glands causes less than 10 per cent. of the total mortality from tuberculosis in this country, and, from the foregoing, it will be seen that about half (thirteen out of twenty-seven) of these are bovine in origin. We may, therefore, assume that 5 to 10 per cent. of the human mortality from tuberculosis in this country is due to infection from bovine sources.

Infection by Ingestion in Man. Experiments have shown that ingestion, as a means of infection in tuberculosis, requires the swallowing of large numbers of tubercle bacilli, unless the intestinal mucous membrane is not intact, in which case a small number will often suffice. The great rarity of primary tuberculosis of the tongue, oral cavity and



Bovine Tuberculosis

Carcase of a cow badly affected with tubercular deposit on the peritoneal surface.
(Dr. Hope's Collection.)

alimentary tract, generally in adults, and the comparative infrequency of primary tuberculosis of the mesenteric glands, except in children, indicate that ingestion, as a means of infection in adults, is rare. The comparative absence of primary tuberculosis of the mesenteric glands in adults is important, for experiments have shown that, unless large numbers of tubercle bacilli are ingested, the intestinal mucous membrane often escapes any local lesion, whilst the mesenteric glands become infected (Sidney Martin).

The presence, however, of abdominal tuberculosis is apparently not essential in all cases of tuberculosis from ingestion. Calmette's and Guerin's experiments led them to believe that tuberculosis of the bronchial glands and lungs could result from feeding with tuberculous material without any intestinal or mesenteric lesions being found.

Latham, in confirming Woodhead's work, showed that tubercle bacilli were present in the tonsils in seven cases out of forty-five consecutive children examined. Active tuberculosis of the tonsils is seldom seen, but the harbouring of tubercle bacilli by the tonsil probably precedes and leads to many of the tuberculous cervical glands in children. By spreading down from these along the lymphatics of the neck, the tubercle bacilli reach the bronchial glands, and have been found to originate in this way an attack of pulmonary tuberculosis. That this is a commoner occurrence than is usually believed is suggested by the frequency with which pulmonary tuberculosis in children starts near the root of the lung adjacent to the bronchial glands.

The fact, however, that during a period in which the use of meat as human food has greatly increased, human tuberculosis has greatly declined, suggests that meat is not a serious source of infection (Royal Commission).

The comparative frequency of the alimentary origin of tuberculosis in children, who ingest more unboiled cow's milk than do adults, indicates that milk, rather than meat, is the usual source of infection by ingestion.

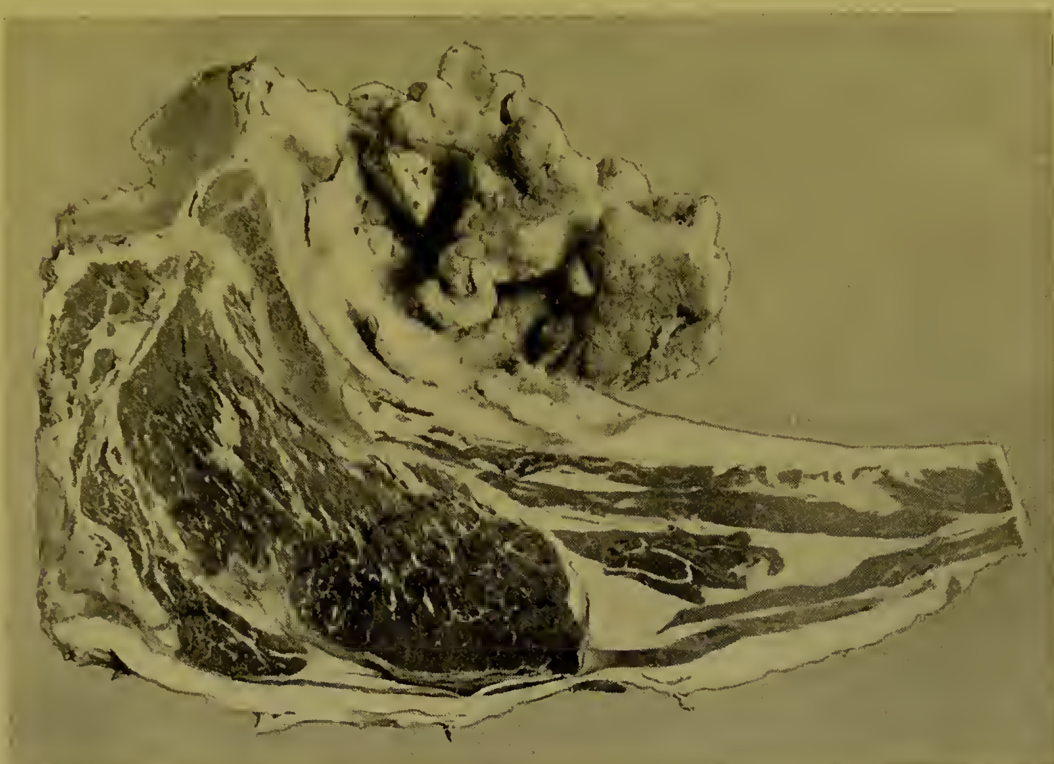
Distribution of Tuberculous Lesions. *In Cattle.* The commonest seats of tuberculous changes are (1) the bronchial and mediastinal glands; (2) the lungs and pleura; (3) the peritoneum, mesenteric glands, liver, pharyngeal glands, udder and kidneys, more or less in the order given. In about 50 per cent. of all cases of tuberculosis, the lungs, with their lymphatic glands, and the pleura are simultaneously affected. In about 30 per cent. the lungs and their lymphatic glands are alone affected. In about 20 per cent. the serous membranes alone are affected.

In the adult ox, the spleen itself is almost exempt from tuberculous changes, although its peritoneal covering suffers as frequently as the rest of the peritoneum. In very advanced cases, the intestines and uterus may be involved, and occasionally the bones are affected. But tuberculous lesions in the muscular tissue itself are very rare.

In Pigs. The method of infection being almost always by ingestion, the lesions are, as one would expect, almost constantly in some part of the alimentary tract. Not, as a rule, till generalisation occurs (and

there is a great tendency to rapid generalisation in the pig) are the lungs seen to be affected. The most frequent seats are the tonsils and the glands of the throat, but the small intestine and mesenteric glands are also commonly affected. The bones, particularly the vertebræ, are more frequently affected in pigs than in cattle, but muscular lesions are rare.

The Flesh of Tuberculous Carcases. As the result of numerous experiments, it is generally believed that, except in the case of local extension, the flesh is only dangerous whilst tubercle bacilli are circulating



Ribs of Beef with Tuberculosis of the Pleura
Large masses of "grapes." (Preparation by S. Delépine.)

in the blood. If there is a miliary tuberculosis of the organs this certainly has occurred, and investigations teach us to suspect its occurrence (1) in the acute stages of tuberculosis; (2) when foci have softened and become purulent, or when there are actual cavities containing pus; (3) when a tuberculous lesion has encroached upon and caused ulceration of the intima of a blood-vessel or the thoracic duct. In all these cases, it is probable that tubercle bacilli have occasionally gained access to the general circulation, and in such cases the flesh is, or has at some time been, dangerous.

Demonstrable naked eye and even microscopic lesions are exceedingly rare in the muscular tissue, except by local extension from a tuberculous bone, joint, or gland.

Animals have been fed on flesh from tuberculous carcases by many experimenters, but when nothing except flesh has been given, positive

results are few, even when the carcases of animals that had suffered from generalised tuberculosis supplied the meat substance.

(1) Nocard records having infected one of four guinea-pigs, by intra-peritoneal inoculation, with muscle juice from twenty-one cows affected by generalised tuberculosis. The flesh of the cows that caused infection, however, failed to infect any of four cats fed on it.

(2) Galtier records similar experiments where he fed cats, dogs, and pigs with as much flesh from tuberculous cattle as they would eat. No case of tuberculosis resulted, although samples from two of the carcases contained muscle juice, that infected with tuberculosis rabbits which were inoculated subcutaneously.

(3) Recognising that infection by ingestion was difficult, Van der Sluys fed ten young pigs with flesh from animals suffering with acute generalised tuberculosis, adding bone splinters to it. Three of the ten pigs developed tuberculosis.

(4) Gerlach records feeding pigs with flesh from a tuberculous sheep and finding that two developed tuberculosis.

(5) Peuch records three positive results when inoculating three rabbits with the muscle juice from a fowl that died of tuberculosis.

The Fruits of Experiments. Experiments have been uniformly positive when the muscle juice from human beings, dead of phthisis, has been used.

Although there are a few contradictory inoculation experiments, the majority have shown that in cattle, even in advanced cases of tuberculosis, and in generalised tuberculosis, the muscular tissue itself is very rarely infective, even with such a delicate test as the inoculation of raw muscle juice into the peritoneal cavity of guinea-pigs. Many of the positive results have been accounted for by contamination of the muscular tissue, during its removal from a tuberculous carcase. This almost constant absence of tubercle bacilli in the muscular tissue has been accounted for by the acidity of muscle being unfavourable for their growth. It is possible, however, that when tubercle bacilli are circulating in the blood, the capillaries of various organs have a greater selective power for them and, as a result, few are arrested in the capillaries of the muscles (McFadyean).

McFadyean and Nocard have both shown that, within a few hours of injecting large numbers of tubercle bacilli into the circulation, the muscles fail to contain any, while the blood itself is free in three to six days.

Even in pigs, in which generalisation is so frequent, experiments fail to demonstrate tubercle bacilli in the muscle. Positive results have, however, been more frequent when using the muscle of tuberculous pigs, sheep, and fowls, instead of cattle.

The Question of Infection. From the foregoing we may conclude that the flesh of tuberculous animals is not necessarily infectious. In many, if not the majority of, cases when the flesh is infectious, this is the result of contamination by means of the knife, butcher's cloth, &c. This

BOVINE TUBERCULOSIS

A typical case of thoracic tubercular deposit (" grapes ").

occurs during the dressing of the carcase, from either the carcase itself or one previously dressed. It has already been stated that large numbers of tubercle bacilli are necessary to infect by ingestion, and, seeing that in the majority of cases tubercle bacilli are absent altogether from the meat, the occasional positive result obtained by inoculating a guinea-pig intraperitoneally does not justify us in saying that the meat would have infected man had he eaten it. It has been stated that Hebrews suffer less than other races from tuberculosis, because of the more careful selection and supervision of the meat they eat. Such statements are incorrect, and have been shown to be so by numerous authorities. The occasions in which tubercle bacilli are liable to gain entrance to the general circulation have already been indicated. In such cases one should look for tuberculous foci of varying ages in the liver, spleen, and kidneys. The intermuscular lymphatic glands would at the same time be affected, and would show more advanced lesions than those in the organs. Foci, in fact, may be found in these glands before they are even evident in the organs. In suspected cases, therefore, these glands should be microscopically examined and the carcase judged accordingly. To remove all the intermuscular glands before the flesh is allowed into the market would be impossible. Although the flesh itself is not infective, its glands make it dangerous. Besides the flesh there are other parts of the animal body that are eaten. Most of the internal organs are a common form of diet, whilst the poorer classes eat the lungs, udder, and mesenteries. All these organs are often highly infective in a tuberculous carcase, and are, therefore, a source of danger to man.

Inspection of Carcase. From the foregoing it will be seen how essential is a proper system of meat inspection. Unfortunately, under present conditions in Great Britain, the stringency or laxity of the inspection instead of being statutory, rests with the sanitary authorities, or those persons appointed by them. As a result, there is doubtless much tuberculous "meat" reaching the market.

Take, for instance, a district in which the inspection of meat is thorough, whilst in neighbouring districts it is purely formal. What results? Cattle, instead of being slaughtered in the district well inspected, where seizure would be almost certain, are slaughtered in an adjacent district badly inspected, and the carcases sent to market in the otherwise safe district. This is probably happening all over the country, and will continue to happen until comprehensive regulations are made and enforced by statute throughout the country.

The Royal Commission made certain recommendations which are adhered to in some parts of the country, and quite ignored in others. They are given on a later page (p. 901).

For tuberculous carcases of pigs they recommended complete seizure, in all circumstances, on account of the great tendency to generalisation. But an inspection, improperly carried out, may do more harm than good. The inspector, for instance, if he is not careful during his examination, may contaminate sound parts of the carcase with tuber-

culous material. Bearing in mind the possibility of contamination in this manner, one should, as far as possible, examine those organs which appear healthy, before cutting into those obviously diseased, and having examined one carcase should use a fresh knife, &c., or boil those used before examining the next carcase.

Roughly speaking, the examination should be made on the following lines: The head having been removed and the carcase halved, begin the examination at the hind-quarters and work forward to the head and neck.

(1) Examine the meat substance and, in the hind-quarters, the lymph glands for that area, *i.e.*, popliteal, precrural, and inguinal.

(2) If the peritoneum appears healthy, examine next the iliac and other retroperitoneal lymph glands. If obviously diseased, leave these glands till later.

(3) Examine the vertebræ, ribs, and sternum.

(4) Examine the prescapular and axillary lymph glands.

(5) If the pleura appears healthy, examine the sternal and intercostal lymph glands.

(6) Examine the mesenteric lymph glands, the udder, kidneys, spleen, liver, and lungs, with their lymph glands, in that order.

(7) Examine the head and the submaxillary and retropharyngeal lymph glands.

Always avoid cutting into tuberculous foci until the healthy parts of the carcase have been examined.

The Effects of Cooking on Tubercle Bacilli. Large numbers of experiments have been carried out to show the power of resistance of tubercle bacilli to heat, and the results show that it is moderate. Ten minutes at 75° Cent. is said by Jersin to be sufficient to destroy the vitality of tubercle bacilli; whilst experiments by Forster show that fifteen minutes at 65° Cent., ten minutes at 70° Cent., and one minute at 95° Cent. are sufficient. Schmidt Mulheim found that, without exception, tubercle bacilli lost their virulence at the coagulation temperature of albumen.

More to the point are the experiments of Woodhead for the Royal Commission, given in Report I., 1895. Working on the hypothesis that the flesh of tuberculous animals was rarely, if ever, infective, unless soiled during dressing of the carcase, he artificially infected the flesh before experimenting. In some cases he injected tuberculous material into the interior of the meat substance, and, in others, he smeared slices of meat and formed them into "rolls." The latter experiment is of importance, as it is the custom for butchers to make such "rolls," and they frequently include minced lungs, omentum, &c., structures which are often highly virulent. Having subjected his samples to the ordinary processes of cooking, and noted the temperature at various depths below the surface, he took the central portions of them for feeding and inoculating animals.

The conclusions he came to were:

(1) The centre of a "joint" weighing 6 lb. or over never reached a higher temperature than 60° Cent. (140° Fahr.) during ordinary cooking.

(2) "Rolls" of meat of more than 3 lb. or 4 lb. weight were not rendered sterile throughout, and therefore cooking could not be relied upon to render innocuous "rolls" with smeared tuberculous centres.

(3) Ordinary cooking was sufficient to destroy any smeared tuberculous material on the outside of a "joint" or "roll."

(4) The most trustworthy method of cooking is boiling, then roasting in an oven, and the least trustworthy, roasting in front of a fire.

The Effects of Preservatives on Tubercle Bacilli. (1) Forster sprinkled pure cultures of tubercle bacilli with sterilised common salt, and found them virulent two months later. (2) He found, also, that finely minced tuberculous organs, after lying in salt brine for eighteen days, retained their virulence. (3) That salting and subsequent smoking did not render the tuberculous organs innocuous, unless these are smoked for three to five hours, on three different occasions, or, after smoking, are kept in a dry room for one or two months.

The Effects of Digestion on Tubercle Bacilli. The gastric juice, being acid, has no doubt a retarding influence on the growth of tubercle bacilli, but it is not, during digestion, in contact sufficiently long to destroy them. Falk and Wesener exposed tuberculous material to artificial gastric juice for some hours, but it was still virulent when tested by the inoculation of animals. Strauss and Wartz showed that six hours in the gastric juice of a dog did not destroy the vitality of tubercle bacilli, but that twenty-four hours were needed. (During the process of digestion three or four hours is probably the longest time any portion of a meal will remain in the human stomach, and much of the food will pass out in a shorter time.) Newsholme suggests that the fatty envelope of tubercle bacilli would probably be dissolved easier in the stomach than under artificial conditions, as the fat-splitting enzyme of the gastric juice is very sensitive to its environment. Stern has demonstrated that the intestinal juice has no effect on tubercle bacilli.

We may, therefore, safely consider (1) that digestion or salting or smoking (as usually carried out) has little or no disinfecting effect on tuberculous meat ; (2) that, owing to the rarity of tuberculosis, ordinary cooking is sufficient, as, with the exception of contaminated "butcher rolls," contaminated meat is thus rendered innocuous. With a more efficient "meat inspection," the quantity of tuberculous organs reaching the market would be reduced to a minimum.

On the strength of what has gone before we may conclude :

(1) That man can contract tuberculosis from cattle, but that, considering the difficulty experienced in transmitting human tuberculosis to cattle, we may, perhaps, assume that the transmission of bovine tuberculosis to man is also difficult to effect.

(2) That infection of man with tuberculosis is not commonly caused by ingesting meat, since it requires the swallowing of large numbers of tubercle bacilli to be effective.

(3) That the flesh of tuberculous animals (even in generalised tuberculosis) is rarely infective, except as a result of post-mortem contamination.

(4) That the ordinary processes of cooking, in the majority of cases, are sufficient to render the contaminated meat non-infective.

(5) That during a period in which the consumption of meat by man has increased in quantity, human tuberculosis has declined (Royal Commission).

We may justly infer, therefore, that, to the community at large, the risk of contracting tuberculosis by eating the meat of tuberculous animals is not so great as is generally believed ; but that this risk is greater than it should be, owing to inefficient methods of inspection. This imperfect inspection particularly concerns those who buy cheap meat, and eat such commonly infected organs as the lungs, udder, and mesenteries. Thus far Dr. Littlejohn's paper.

Regulations Regarding Tubercular Meat. In the absence of any legal enactments as to the dealing with meat from tubercular carcases, it will be well to note briefly the recommendations of various authorities on this vexed question. There are many divergent views on the subject, and hence difficulty ensues. We would draw attention to the following paragraphs, which put the matter from the American point of view (Bureau of Animal Industry, 24th Report, pp. 368, 369, 370). It is evident that it is in connection with tuberculosis that the Department has the greatest difficulty in harmonising contending views. This is natural, inasmuch as tuberculosis is the most common diseased condition with which inspectors have to deal, and the popular prejudice against using meat from tuberculous animals is more widespread than is the prejudice against diseases with which the public is less familiar.

"It cannot be too strongly insisted that the slaughterhouse under inspection is the proper place for all live-stock infected with tuberculosis, unless such animals are manifestly affected with advanced or generalised tuberculosis, in which case they should be sent for slaughter to a fertiliser establishment. The sooner these animals, with the exception noted, are led into such slaughterhouses, the sooner this disease will be eliminated from the dairy herds. At these slaughterhouses these animals should be inspected ; the meat should then be judged on rational principles rather than on sentimental ideas ; such meat as can safely be used for food should be treated accordingly, and other cases should be treated in such a way that they can do no harm.

"Persons who desire to see the public safeguarded against tuberculosis will do well to consider the subject from a rational point of view rather than a sentimental one, which is calculated not only to support a policy which is irrational, scientifically unjustified, unduly expensive, and economically and practically of impossible general application, but which inherently has a tendency to inhibit dairy-herd owners from joining in a movement to eradicate the disease."

The commission adopts the following principles in connection with meat inspection for tuberculosis :

Principles to be applied in Tubercular Carcases. "(1) The fundamental thought is that meat should not be used for food if it contains tubercle bacilli, if there is a reasonable possibility that it may contain tubercle bacilli, or if it is impregnated with toxic substances of tuberculosis or associated septic infections.

"(2) On the other hand, if the lesions are localised, if there is no distribution of tubercle bacilli through the blood, or by other means, to the muscles, or to parts that may be eaten with the muscles, and if the animal is well nourished and in good condition, there is no proof or reason to suspect that the flesh is unwholesome.

"(3) **Generalised Tuberculosis.** Evidences of generalised tuberculosis are to be sought in such distribution and number of tuberculous lesions as can be explained only upon the supposition of the entrance of tubercle bacilli in considerable number into the systematic circulation. Significant of such generalisation are the presence of numerous uniformly distributed tubercles throughout both lungs, also tubercles in the spleen, kidneys, bones, joints and sexual glands, and the lymphatic glands connected with these organs and parts, or the splenic, the renal, the prescapular, the popliteal and inguinal glands, when several of these organs and parts are coincidently affected.

"(4) **Localised Tuberculosis.** By localised tuberculosis is understood tuberculosis limited to a single or several parts or organs of the body without evidence of recent invasion of numerous bacilli into the systematic circulation.

"**Rules for the Disposition of Meats.** *Rule A.* The entire carcase shall be condemned :

"(1) When it was observed before the animal was killed that it was suffering with fever.

"(2) When there is a tuberculous or other cachexia, as shown by anæmia and emaciation.

"(3) When the lesions of tuberculosis are generalised, as shown by their presence, not only at the usual seats of primary infections, but also in parts of the carcase or the organs that may be reached by the bacilli of tuberculosis only when they are carried in the systematic circulation. Tuberculous lesions in any two of the following organs are to be accepted as evidence of generalisation when they occur in addition to local tuberculous lesions in the digestive or respiratory tracts, including the lymphatic glands connected therewith : (*a*) spleen, (*b*) kidney, (*c*) uterus, (*d*) udder, (*e*) ovary, (*f*) testicle, (*g*) adrenal gland, (*h*) brain or spinal cord or their membranes.

"(4) When the lesions of tuberculosis are found in the muscles or intermuscular tissue or bones or joints, or in the lymphatic glands which drain the muscles, bones, or joints.

"(5) When the lesions of tuberculosis are extensive in one or both cavities.

"(6) When the lesions are multiple, acute, and actively progressive. Evidence of active progress consists in signs of acute inflammation

about the lesions, or liquefactive necrosis, or the presence of young tubercles.

" *Rule B.* An organ or a part of a carcase shall be condemned :

" (1) When it contains lesions of tuberculosis.

" (2) When the corresponding lymphatic glands are tuberculous.

" (3) When the lesion is immediately adjacent to the flesh, as in the case of tuberculosis of the parietal pleura or peritoneum, not only the membrane or part affected, but also the adjacent thoracic wall or abdominal wall, is to be condemned.

" (4) When it has been contaminated by tuberculous material, through contact with the floor, a soiled knife, or otherwise.

" *Rule C.* The carcase, if otherwise healthful, and if none of the conditions described in Rule A are present, shall be passed, after the parts containing localised lesions are removed in accordance with Rule B.

" *Rule D.* Carcases of animals affected with tuberculosis [except those mentioned under Rule A, (1) and (2)] may be rendered into tallow or lard when the disease is not generalised and extensive and is of such distribution that all parts containing tuberculous lesions may be removed. Such carcases shall be cooked by steam at a temperature not lower than 220° Fahr. for not less than four hours.

" *Rule E.* All condemned carcases, parts of carcases, or organs showing lesions of tuberculosis shall be deposited in receptacles provided for that purpose, and shall either be tanked at once or be locked in the ' condemned ' room until such time as an employee of the Department can see that they are placed in the tank."

The foregoing regulations are well worthy of careful study by inspectors, and together with those of our own L.G.B. based upon the suggestions of the British Commission will form a guide to the inspector in many cases in which he might otherwise have some doubt as to his proper procedure.

Inspection in the Interest of the Meat-purveyor. We would add that the person most interested financially in securing a thorough and scientific examination and inspection is the butcher or meat-purveyor who owns the carcase, for the simple reason that where there are but few inspectors to do the work very little time can be given to each case ; and wholesale condemnation is apt to occur in order to be on the safe side. It is only where there are plenty of inspectors, who really know their work, that parts of carcases will be passed and saved for food. This point is too often lost sight of by those whose business it is to sell meat, but there can be no doubt that if we are to save the many tons of meat which are now condemned in this country simply because the carcase has some tubercle in it, and because the inspector has no time for a detailed examination, the only way to do so consistent with the safety of the public health is to secure a uniform system and vastly more numerous inspectors.

The Royal Commission on Tuberculosis (1898) made the following Recommendations which are more or less followed in Britain :

TUBERCULOSIS IN ANIMALS INTENDED FOR FOOD

" We recommend that the Local Government Board be empowered to issue instructions from time to time for the guidance of meat inspectors, prescribing the degree of tubercular disease which, in the opinion of the Board, should cause a carcase, or part thereof, to be seized.

" Pending the issue of such instructions, we are of opinion that the following principles should be observed in the inspection of tuberculous carcases of cattle :

<table>
<tr><td>" (a) When there is miliary tuberculosis of both lungs.</td><td rowspan="4">The entire carcase and all organs may be seized.</td></tr>
<tr><td>" (b) When tuberculous lesions are present on the pleura and peritoneum.</td></tr>
<tr><td>" (c) When tuberculous lesions are present in the muscular system, or in the lymphatic glands embedded in or between the muscles.</td></tr>
<tr><td>" (d) When tuberculous lesions exist in any part of an emaciated carcase.</td></tr>
</table>

<table>
<tr><td>" (a) When the lesions are confined to the lungs and the thoracic lymphatic glands.</td><td rowspan="4">The carcase, if otherwise healthy, shall not be condemned, but every part of it containing tuberculous lesions shall be seized.</td></tr>
<tr><td>" (b) When the lesions are confined to the liver.</td></tr>
<tr><td>" (c) When the lesions are confined to the pharyngeal lymphatic glands.</td></tr>
<tr><td>" (d) When the lesions are confined to any combination of the foregoing, but are collectively small in extent.</td></tr>
</table>

" In view of the greater tendency to generalisation of tuberculosis in the pig, we consider that the presence of tubercular deposit in any degree should involve seizure of the whole carcase and of the organs.

" In respect of foreign dead meat, seizure should ensue in every case where the pleura have been ' stripped.' "

REPORT ON AN INVESTIGATION WITH REGARD TO THE VALUE OF TUBERCULIN AS A TEST OF THE PRESENCE OF TUBERCULOSIS IN CATTLE

By permission of J. McLauchlan Young, Esq., F.R.C.V.S., we are enabled to quote the results of his investigation into this matter, in which he was assisted by Mr. J. S. H. Walker.

" Most of the cattle were tested before removal from the farms, but several animals, cows especially, were tested in the byres of the slaughter-houses after being there for at least twenty-four hours.

" The tuberculin we used was obtained from the Royal Veterinary College, London, and care was taken regularly to disinfect the syringe in corrosive sublimate solution (1–1000), and to cleanse the needle by boiling. The animals were inoculated immediately behind the shoulder, the opera-

tion being performed in the evening, except in a few cases. The temperature was taken at the tenth, eleventh, twelfth, and thirteenth hours after inoculation. As a general rule, Mr. Young applied the tuberculin and noted the results on the live animal, while Dr. Walker, who was kept in ignorance of these results, conducted the post-mortem examination. It may be mentioned that these operations were frequently witnessed by interested spectators, and that we were occasionally honoured with the presence of veterinary surgeons and members of the medical profession.

"Two hundred and forty cattle were tested and examined, and these consisted of 100 bullocks, 60 heifers, 77 cows, and 3 bulls.

"The bullocks, with a single exception, were two years old; the heifers, with a single exception, were one or two months younger; the bulls were three years, while the average age of the cows was seven and a half years.

"We desire to call attention to a few outstanding particulars.

"**Bullocks.** Twenty reacted after inoculation, and were found on slaughter to be tuberculous. Another, No. 7, was suspected to be tuberculous because the temperature rose to 103°, and the animal became dull and refused to eat. This animal proved to be tuberculous. Nos. 3, 19, and 55 gave no reaction, but were found to be tuberculous. In No. 3 the lesion consisted of a fibrous nodule about the size of a hazel-nut in the left lung, an old encysted tubercle which appeared to be no longer active. In Nos. 19 and 55 the only lesion was a small calcareous tubercle about half the size of a pea in a mesenteric gland. In one of the cases the gland was pronounced by Professor Hamilton after microscopic examination to be tuberculous. In the other case a guinea-pig was inoculated with matter from the lesion with the result that tubercle bacilli were recognised in the lesions of the guinea-pig.

"**Heifers.** Six reacted and proved to be tuberculous. Four, which fialed to react, were found to be tuberculous. Two of these, Nos. 28 and 30, formed part of a small lot which were purposely tested with a mixture of fresh and old tuberculin, the old portion having been in store for more than a year. In the third of the cases, No. 37, in which there was a slight rise of temperature, the dose of tuberculin was probably deficient in quantity, owing to a defect which was found in the syringe allowing some of the contents to escape. And the fourth, No. 60, was an extremely diminutive creature about three years old, for which the dose was probably under-estimated and made too small.

"**Cows.** It is not the custom to slaughter a large number of cows at any one centre. For this reason, and with the view of observing the incidence of the disease in various parts of the country, we visited several places in Aberdeenshire and in the neighbourhood of Newcastle, and were successful in getting access to seventy-seven cows of various breeds and ages. Of these, forty-two were found on slaughter to be tuberculous, although only twenty-five had reacted after inoculation. The latter were mostly young cows, while the tuberculous cows that failed to react were all old. Further, the lesions in those which reacted were found

PLATE XIX

TUBERCULOSIS OF THE PIG

A pig's spleen from a case of generalised tuberculosis. The nodules are scattered throughout the substance of the organ.

in every case to be much less extensive than in the others. We have thus found the tuberculin test ineffectual when the disease has existed for some considerable time and has become generalised, especially if the animal is old and more or less emaciated.

"**Bulls.** One reacted, and was found on post-mortem examination to have the lungs and pleura on the left side tuberculous.

"The disease in bullocks and heifers was found most commonly in the bronchial and mediastinal glands, occurring in these organs in twenty-five cases. Next in frequency the lungs were affected, there being fifteen instances of lung affection, while in seven of these the lesions were confined to the lungs. The pharyngeal glands were diseased in seven instances and the mesenteric glands in five. In three of the mesenteric cases the disease appeared to be part of a general affection, while in the two others it was confined to the mesenteric glands, the lesion was minute, and there had been no reaction. The disease was found in the pleura in three cases, on the peritoneum in two, and in the liver in five.

"In nearly all the cows the bronchial and mediastinal glands and the lungs were affected, while lesions were found in the pleura in eleven cases only. The liver was diseased in thirteen instances, the peritoneum in five, the right kidney in one, and the udder in seven, in two very extensively. A remarkable difference was observed in the prevalence of the disease in cows as compared with heifers. We found it occurring in 16.6 per cent. of the heifers and in 54.5 per cent. of the cows. We are thus led to suppose that a large number of the cows had become tuberculous after having attained maturity. This consideration appears to emphasise the infectious character of the disease.

"According to some authorities the udder is rarely the seat of tuberculosis, but our investigation indicates that the fact is otherwise. We found that almost 10 per cent. of the cows had tuberculous udders, and that over 16 per cent. of the tuberculous cows had tubercle in the udder. It is to be noted that only one of the udder-affected cows could be called 'a piner,' while the others were ordinary dairy cows in fair condition. The prevalence of tuberculosis in udders explains how tuberculosis may be conveyed from cows to calves, and disseminated in a herd.

"It will be observed that every animal which reacted under the test proved on post-mortem examination to be tuberculous, and that seventy-seven of the animals, or 31.7 per cent. were affected.

"We have arrived at the following general conclusions, which we take leave to state with considerable confidence :

"(1) Our experience confirms the generally accepted opinion that tuberculin loses its virulency when kept for any length of time.

"(2) When used with care and under proper conditions tuberculin is a reliable diagnostic of tuberculosis in cattle, except (*a*) when the tubercular lesion is minute, or (*b*) when the disease has become generalised, especially in the case of aged and emaciated animals.

"(3) Tuberculous udder occurs more frequently than is generally believed to be the case."

CHAPTER IX

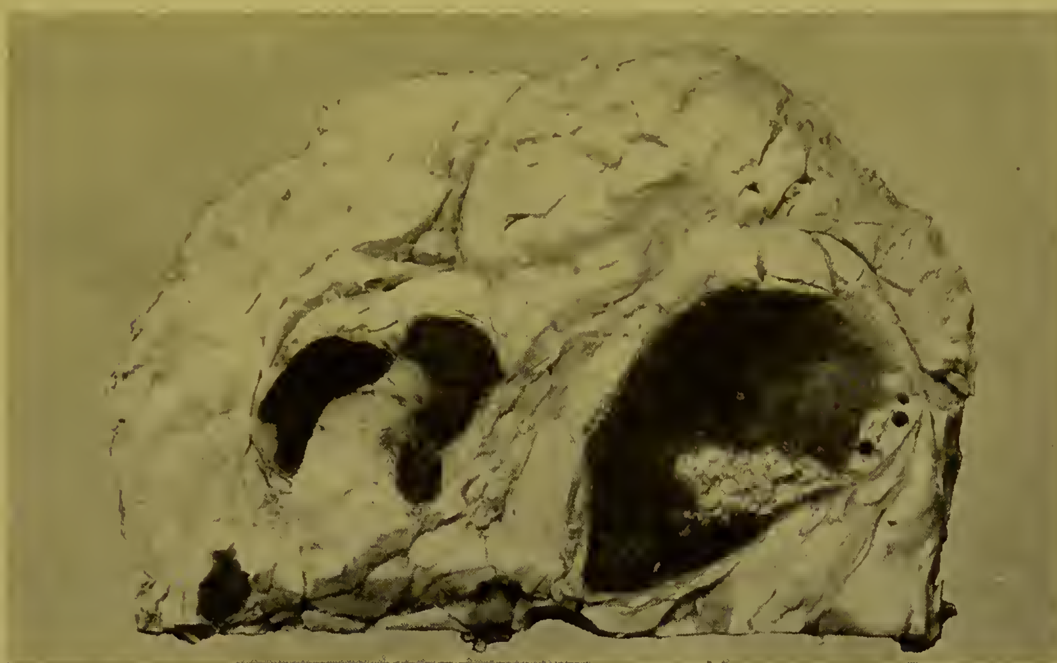
ANTHRAX, ETC., IN ANIMALS

Anthrax occurs from time to time epizootically in sheep, cattle, and, more rarely, in horses and deer. These epizootics are found in various parts of the world, although they are naturally most far-reaching where legal precautions to prevent the spread of infection are non-existent. All the countries of Europe are, from time to time, visited by the disease, but in some it is much more common than in others. In Britain the death-rate is small, but in France the annual mortality among sheep was probably 10 per cent. of the total number in the country, and among cattle 5 per cent. These figures, however, have been largely modified by the system of preventive treatment, which will be presently described.

Symptoms of Anthrax. In sheep and cattle the disease is specially virulent. An animal may suddenly drop down, with symptoms of collapse, quickening of pulse and respiration, and dyspnœa, and death may occur in a few minutes. In less acute cases the animal is apparently out of sorts, and does not feed ; its pulse and respiration are quickened ; rigors occur, succeeded by high temperature ; there is a sanguineous discharge from the bowels, and bloody mucus may be observed about the mouth and nose. There may be convulsive movements ; there is progressive weakness, with cyanosis, death occurring in from twelve to forty-eight hours. In the more prolonged cases widespread œdema and extensive enlargement of lymphatic glands are marked features ; and in the glands, especially about the neck, actual necrosis with ulceration may occur, constituting the so-called anthrax carbuncles. Such subacute conditions are especially found among horses, which are by nature not so susceptible to the disease as cattle and sheep.

Post-mortem Conditions in Anthrax. On post-mortem examination of an ox dead of anthrax, the most noticeable feature—one which has given the name "splenic fever" to the disease—is the enlargement of the spleen, which may be two to three times its natural size. It is of dark red colour, and on section the pulp is very soft and friable, sometimes almost diffluent. A cover-glass preparation may be made from the spleen and stained with watery methylene-blue. On examination, it will be found to contain enormous numbers of bacilli mixed with red corpuscles and leucocytes, chiefly lymphocytes and the large mononucleated variety. Pieces of the organ may be hardened in absolute alcohol, and sections cut in paraffin. These are best stained by Gram's method. Microscopic examination of such shows that the structure of the pulp is considerably disintegrated, whilst the bacilli swarm through-

out the organ, lying irregularly amongst the cellular elements. The liver is enlarged and congested, and may be in a state of acute cloudy swelling. The bacilli are present in the capillaries throughout the organ, but are not so numerous as in the spleen. The kidney is in a similar condition, and here the bacilli are chiefly found in the capillaries of the glomeruli, which often appear as if injected with them. The lungs are congested and may show catarrh, whilst bacilli are present in large numbers throughout the capillaries, and may also be found in the air



Lumbar Lymphatic Glands in the Retroperitoneal Fat of a Cow Dead of Anthrax

Anthrax bacilli abundant in the blood. (Preparation by S. Delépine.)

cells, probably as the result of rupture of the capillaries. The blood throughout the body is usually fluid and of dark colour.

The lymphatic system generally is much affected. The glands, especially the mediastinal, mesenteric, and cervical glands, are enlarged and surrounded by œdematous tissue ; the lymphatic vessels are swollen, and both glands and vessels may contain numberless bacilli. The heart may be in a state of cloudy swelling, and the blood in its cavities contains bacilli, though in smaller numbers than that in the capillaries. The intestines are enormously congested, the epithelium more or less desquamated, and the lumen filled with a bloody fluid. From all the organs the bacilli can easily be isolated by stroke cultures on agar.

Susceptibility to the Disease. It is important to note the existence of great differences in susceptibility to anthrax in different species of animals. Thus the ox, sheep (except those of Algeria, which only succumb to enormous doses of the bacilli), guinea-pig, and mouse are all very susceptible, the rabbit slightly less so. The last three are, of course, most used for experimental inoculation. We have no data to determine

whether the disease occurs among these in the wild state. Less susceptible than this group are the horse, deer, goat, in which the disease occurs from time to time in nature. Anthrax also occurs epidemically in the pig, often from the ingestion of the organs of other animals dead of the disease. It is, however, doubtful if all the cases of disease in the pig described on clinical grounds as anthrax are really such, and a careful bacteriological examination is always advisable. The human subject may be said to occupy a medium position between the highly susceptible and the relatively immune animals. The white rat is highly immune to the disease, while the brown rat is susceptible. Adult carnivora are also very immune, and the birds and amphibia are in the same position.

With these differences in susceptibility there are also great variations in the pathological effects produced in the natural or artificial disease. This is especially the case when we consider the distribution of the bacilli in the bodies of the less susceptible animals. Instead of the widespread occurrence described above, they may be confined to the point where they first gained access to the body and the lymphatic system in relation to it, or may be only very sparsely scattered in organs such as the spleen (which is often not enlarged), the lungs, or kidneys. Nevertheless the cellular structure of the organs even in such a case may show changes, a fact which is important when we consider the essential pathology of the disease.

THE CAUSATION AND SPREAD OF ANTHRAX*

"The extraordinary prevalence of anthrax in the county of Aberdeen suggested an inquiry into its causation and spread, and the information obtained during the past four years is now published in this report. In order to make this report as comprehensive and useful as possible, it may be of value to give a short description of the disease before proceeding to statistics.

"Anthrax is classed as a rapidly fatal form of septicæmia or blood disease, or, in other words, it is due to a pathogenic or disease-producing organism having entered the blood-stream. This organism is known as the *Bacillus anthracis*, and without this organism no anthrax can exist. Anthrax has been ascribed to various foods and feeding-stuffs, but it must be clearly understood that the food has simply acted as the vehicle by which the bacillus has been carried into the animal body. Inoculation might take place by some external wound, such as in the foot or body, but in the vast majority of cases the virus has been introduced by the alimentary tract. It is more difficult to prove how the bacillus found its way into the food, but before entering on that question it may help us to notice some interesting and important facts concerning the organism itself."

The Bacillus Anthracis. "The *Bacillus anthracis* is a rod-shaped organism, with square-cut ends, and, although microscopic, is large

* By J. McLauchlan Young (by permission).

when compared with many other pathogenic micro-organisms. As early as 1849 Pollender, and in 1856 Rayer and Davaine, demonstrated the bacillus in the blood of animals which had died from splenic apoplexy, and in 1857 Brauell found the same bacillus in the blood of a man. To-day we know, except under special circumstances, it is always to be found in the blood of an animal which has died from anthrax, and it may also be present in the discharges from the mouth, nose, and anus. It does not possess the power of movement, and multiplies by division, *i.e.*, each rod divides, and each division grows until it in turn divides. This process is quite different from the formation of spores, which the *Bacillus anthracis* rarely, if ever, does within the body. Spores are sometimes called eggs, but this is not strictly correct, as their formation is a resting stage in the history of the organism, and are only formed when the bacillus finds itself unable to live because of adverse conditions. Under such circumstances the bacilli form spores, much more tenacious of life, and which because of being enclosed in a thick membrane are able to stand heat, cold, and comparatively strong disinfectants. Not only so, but under circumstances which would rapidly prove fatal to the bacilli, the spores remain viable for years, this being nature's way of preventing the extinction of the organism. The bacilli are killed by two minutes' exposure to a 1 per cent. solution of carbolic acid in water, but the spores will remain alive for more than a week in a similar solution. Koch found they resisted boiling for five minutes, and dry heat to kill them must be applied for several hours at 140° Cent."

Modes of Infection. "In a dry condition they possess their power of inducing disease for an indefinite period, while, unlike the bacillus, they can resist the action of gastric juice for many hours. A decomposing carcase admits of a condition favourable to the development of spores as there is free access to the air, but during the putrefactive process the bacilli are killed, and in ten days or thereby very few remain. The spores are unaffected and may remain alive, though latent, for years, or they may germinate, multiply and grow on the organic matter present in the soil; but if the bacilli thus formed are swallowed they are killed by the gastric juice. But the spores may lie, as spores, in the ground until ingested by an animal, when they can pass uninjured through the stomach, and gaining an entrance into the intestine infect its wall, and ultimately reach and multiply in the blood, causing death. Perhaps a more frequent mode of infection is through open wounds in the lips, gums, or tongue, and this offers the explanation why so many oxen die of anthrax when rising two years of age. At this time they are casting the two middle incisors or front teeth, and thus offering an easy access to the bacilli or spores. The bacilli, or more likely the spores, may be carried by any one of the many varieties of foods, and if the soil be infected, roots bearing particles of soil will become a ready means of conveyance. During the summer grazing it is easy for the animal to have small wounds in the neighbourhood of the mouth from pieces of glass, broken jars, sharp stones, or thorns. Foreign manures, especially

bone, have been said to infect the soil, and, although this is a likely means, the evidence is not strong enough to warrant any interference with the trade. Two descriptions of bones are imported into this country, known to the trade as 'Plano or Campo,' and 'Kitchen or Consumo.' The first are bones picked up on grazing lands, and are mostly of animals which have died. The second are bones from meat-extract factories, and in the preparation of the extract have been boiled, and are thus less likely to convey pathogenic spores. As heating bones does not lessen their manurial value—in fact improves it—it might be well if all bones were subjected to such a temperature and for such a time as would destroy all possibility of conveying disease."

Experiments with Bones. "During the last three months of 1904 I carried out a long series of experiments with a sample of bones from a cargo just imported, but all the results were negative.

"About the same time I visited a farm where anthrax kept occurring year after year, and on making inquiries I was directed to a field where a large number of animals had been buried during the past twenty years. I took samples of soil, at a depth of 9 or 10 in., from several graves, and found one of the samples contained anthrax. This sample was taken from a grave at the upper part of a field where a yearling stirk, supposed to have died from quarter ill, had been buried. I also ascertained that this was the most recent burial on the farm. Another farm in the same district with a somewhat similar history was visited, and on inquiry the following interesting and suggestive facts were elicited :

"Three animals had died from anthrax. Two parts of a field—one at the side and the other a hollow near the centre—had for years been used as the burial-places for all animals dying on the farm. The drainage from both places runs into a small stream which formed the drinking water of the three dead animals. For about ten days prior to their death the animals had been grazing in a field separated from the first burial-place by a very poor wire fence, and they were repeatedly seen eating the grass growing on the graves. Samples of soil were taken from both places, but cultivations and inoculations all proved negative.

"In another case stable and byre manure, which we had reason to suspect had become infected by the blood of an animal which had died from anthrax, was innocently spread over a field. I took several samples of soil and manure from different parts of the field, and Professor Hamilton found anthrax in most of them. The following year another animal died from anthrax, and it was ascertained that it had been fed on tares grown on this particular field. In many other cases investigated on the same lines the results proved negative, but the history of the cases gave one the opinion, had the proper sample been taken, anthrax would have been found. How many cattle must have grazed or partaken of crops raised on that soil, yet they escaped, while the one, unfortunate enough to graze on the infected spot or to partake of the one quantity of infected food, paid forfeit with its life ?

"On a farm in Aberdeenshire an animal died, in October 1903, of

anthrax, and was buried in a field which this year (1908) is in turnips. No case has occurred since until this year, when an animal fed on the turnips from that field died of anthrax. We cannot trace the actual connection, but it is suggestive."

Agents in the Spread of Anthrax. "It was said by Pasteur and confirmed by Bollinger that earth-worms were agents in the spread of anthrax by bringing to the surface the spores. Koch denied this, but his explanation of the recrudescence of epidemics in fields where anthrax carcases had been buried is much less feasible than that advanced by Pasteur.

"There seems little doubt that the soil plays a considerable part in the cause and spread of the disease, and, as if by the irony of fate, cultivated ground is always richer in bacterial growth than virgin soil. While there is a difference in composition the cultivated soil has always greater opportunity of contamination, and certainly carries more stock. The carcases of animals known to have died from anthrax are carefully disposed of and the premises disinfected, but there are many animals which die, and, anthrax not being suspected, their carcases are improperly buried.

"The possibility of sheep being factors in the dissemination was suggested to me by seeing a shepherd, after skinning a fallen sheep, drag the carcase along the ground for at least 100 yards, and finally throw it in a small stream Had that sheep died of anthrax, the spot where it was skinned and the track along which it was drawn, to say nothing of the water in the lower part of the stream, must have been infected and likely to reproduce the disease. Not only so, but the skin was removed home, where it, in turn, had every opportunity of causing an outbreak, as preventive measures would be unthought of. The fact that the sheep is dead is sufficient for the shepherd, and he straightway proceeds to skin and dispose of the carcase in the most perfunctory manner without ever thinking of ascertaining the cause of death."

FURTHER FACTS ON ANTHRAX

In January 1899, the Board of Agriculture issued the following information :

"Anthrax has long been known as a very fatal disease. Prior to the discovery of its cause it was attributed to feeding cattle on highly nutritious or artificial foods, which induced an attack of apoplexy or enlargement of the spleen, resulting in the sudden death of the animal. It is believed that this view as to the cause of anthrax still exists in many parts of the country, for it is a common practice amongst owners of stock, who are unaware of its dangerous and fatal character, to slaughter their cattle as soon as they present serious symptoms of illness, in order to sell the hide or to utilise the carcase for human food. The blood of the diseased animal is no doubt in many cases distributed over the floors of the sheds, or upon the mangers, or is carried upon the boots of the attendants, and infects other parts of the farm or premises.

"It is important that it should be widely known that the view formerly entertained as to the nature of anthrax is erroneous, and that the disease is entirely due to the introduction into the blood of an animal, or of man, of the minute spores or germs contained within the anthrax bacilli, which are always to be found in the blood of animals recently dead of anthrax."

To Prevent the Disease spreading. "The bacilli of anthrax and the spores therein die speedily if kept within the intact carcase, but multiply with great rapidity if they are exposed to the air.

"It will thus be recognised that in order to prevent the extension of anthrax from diseased to healthy animals, or to persons, it is essential that the diseased carcase should not be opened, and that none of the blood or natural secretions that may contain some blood should escape, as the spores contained within the blood will multiply with rapidity, and when exposed to the air may become the means of infecting other animals.

"In most instances, the first intimation of an outbreak of anthrax or splenic fever is the discovery of a dead animal in the pasture or byre. Perhaps the animal was left a few hours before in apparent health; at least there was nothing to attract attention, or give any warning, of the near approach of death. Occasionally there are certain premonitory symptoms of an attack of anthrax which can be recognised by an expert. The affected animal is dull and disinclined to move. If one of a herd at pasture is attacked, the fact is indicated by the separation of the sick animal from the rest. From time to time the animal will cease to feed, and stand with the head bent towards the ground, and sometimes a little blood is discharged from the nose and also with the fæces. Close attention will enable the observer to detect an occasional shiver and trembling of the limbs, which seems to pass rapidly over the body, and then ceases. The shivering fits now become more frequent, and perhaps while these signs are being noted, the animal will suddenly roll over on its side, and, after a few violent struggles, expire. On close inspection, especially in the case of swine, it will often be found that there is a good deal of swelling under the throat, extending down the neck; and the swollen part will at first be hot and tender to the touch, but as the disease goes on it becomes insensitive, cold, and clammy."

How Anthrax is transmitted. "Although a communicable disease, anthrax is not transmitted from the living diseased animal to the healthy by association, as in the case of cattle plague, foot and mouth disease, or other animal diseases of a contagious nature, but is almost invariably transmitted to the healthy animal through the medium of food or water containing the spores of the disease. These spores may also find their way into the circulation through a cut or abrasion. The disease may be introduced through the spreading of infected manure on the pastures, and occasionally outbreaks have been directly traced to the distribution upon the farms of manure containing the cuttings or scrapings of hides.

"In their own interest the owners of stock should permit their animals when affected with anthrax to die, rather than slaughter them in the

ANTHRAX IN HUMAN BEING
(Reproduced by permission of New Zealand Government.)

ANTHRAX AFFECTING ARMS (RECOVERING)
(Reproduced by permission of the New Zealand Government.)

ordinary way, and thus infect their sheds, stock-yards, and other parts of their farm and premises, and possibly cause the death of those persons who may be engaged in slaughtering them.

"It will be gathered from the preceding remarks that, since the means by which anthrax may be spread are different from those of other contagious diseases of stock, the measures to be adopted for preventing its extension should also be dissimilar.

"Whenever an animal with suspicious symptoms during life dies suddenly from an unaccountable cause, the fact should be at once reported to the local authority, and the owner should forthwith plug the nostrils and all the natural openings with hay or tow saturated with a strong solution of carbolic acid, to prevent the oozing of any blood therefrom. The veterinary inspector should at once inquire as to the cause of death, and determine by careful investigation whether anthrax exists or not. This can be done soon after death by examining with a microscope a few drops of blood taken from one of the superficial veins."

When the Disease breaks out. "It having been decided that the disease to be dealt with is anthrax, the owner should cause all the cattle, sheep, or swine that have been in association with the dead animal, and are pronounced by the veterinary inspector to be apparently healthy, to be moved as soon as possible from the shed or field or other place where the disease has originated, to some other place on the farm or premises, there to be isolated. These animals should be given an entire change of food and water, and as the period of incubation of anthrax is usually very short, isolation for seven days will usually be sufficient to enable the veterinary inspector to determine whether any of these animals are affected or not.

"For the burial of the carcase some part of the farm should be selected which is remote from the water-course, and to which animals cannot, and do not ordinarily, have access, such as a wood or enclosure. The burial and disinfection of the carcase will be carried out under the supervision of an inspector of the local authority.

"The inspector of the local authority should then carry out or supervise a rigid system of disinfection of the place or premises where the diseased animal has been detained or has died, and of all manure and broken fodder remaining therein.

"The main cause of the periodic recurrence and persistence of anthrax on many farms in this country has no doubt been due to the skinning of the diseased carcases and to the want of proper precautions for the burial and their disinfection. The most effectual manner of destroying the germs of anthrax is by burning the carcase, or by destroying it by means of chemical agents, and when facilities exist for carrying out either of these methods, a licence of the Board must be previously obtained. In cases where burial is adopted every facility should be afforded by the owner to the inspector of the local authority in order that his duty may be effectually carried out.

'It has been found by experience that where all the above-named

precautions have been scrupulously adhered to, the disease frequently ceases after the death of one animal on the farm."

Anthrax is such an important and dangerous disease that no explanation is required for dealing with it as fully as we have done in the foregoing pages.

Malignant Œdema. This bacterial disease, due to the bacillus of malignant œdema, which was investigated by Koch, occurs when injuries and accidents produce wounds along with contamination, especially from soil. Authorities differ somewhat as to the susceptibility of the various animals, concerning which we may mention the following statements. Kitt is of opinion that a bacillus of œdema may cause swellings of a local nature in cattle, and the same observer has shown malignant œdema can be inoculated into horses, calves, sheep, goats, and swine. Chauveau and Arloing are of the opinion that cattle are immune to this condition, while other writers state that cases have been reported in the ox which have occurred naturally, but that this animal is immune to experimental inoculation. The characters of the bacillus are described elsewhere (*see* Bacteriology). The lesions produced are those of a subcutaneous swelling with emphysema and rapidly following gangrene, with therefore putrefactive odour.

As far as is known, human beings are not susceptible to this disease, but there is no doubt that carcases showing lesions such as have been mentioned cannot be considered as fit for human consumption, since the animal is in a feverish condition and the carcase will rapidly undergo decomposition.

Tetanus. This bacterial disease, caused by the bacillus of tetanus, and commonly known as lock-jaw, is characterised by the tonic spasms of various groups of muscles during life. The bacillus itself is described elsewhere (*see* Bacteriology). Of the domestic animals affected the horse comes easily first, but tetanus also occurs in cattle and sheep and in cows after parturition. It occasionally attacks calves and lambs, from umbilical infection, and sometimes also sheep and goats. This is another example of a bacterial infection in which all the evidence goes to show that human beings run no particular risk of contracting the disease itself by eating meat from an animal which has suffered, though at the same time the meat inspector will condemn the carcase on account of its inferior quality for food material. It must be remembered that the entrance of the organism itself is associated with the presence of a wound, and it is generally held that if the animal die from the condition it does not set well and shows hyaline degeneration of some of the muscles. Before the organismal nature of tetanus was known, there was no hesitation in passing such meat for food, and apparently no harm follows the ingestion even of the bacilli themselves. Experimenters have proved that large quantities of the bacillus can be swallowed without injurious results, and probably the organism requires the presence of other organisms before it develops its most virulent properties.

Gerlach gave pigs large quantities of horse-flesh from horses which

had died of tetanus without producing the condition in the swine. He also demonstrated that a dose of the bacilli ten thousand times greater than the minimum lethal subcutaneous dose could be taken with impunity by the digestive tract. He therefore considers such meat harmless. It is to be remembered, however, that the organism is rendered harmless by the action of gastric juice.

Judgment in Tetanus. The meat inspector's judgment will be to condemn animals dying from tetanus as unfit for food on grounds which

A Case of Black-quarter

The emphysematous swelling in the subcutaneous tissue of the shoulder should be noted.

Photo by Mr. Roberts, M.R.C.V.S.

have already been fully considered, namely, deficient bleeding which follows all natural deaths and the pathological lesions associated with the disease. The question may possibly arise whether if an animal which was slaughtered in the early stages of tetanus may not be considered marketable. Each such case must be judged upon its own merits.

Black-quarter. This disease is known by a good many different names in different parts of the country, the following being the most common synonyms: blackleg, quarter ill, quarter evil, murrain, black spauld, &c. It is one of the few bacterial diseases which produce effects particularly in the musculature, in which, owing to the production of

gas, there is seen on one of the quarters of the animal an emphysematous swelling. It is practically only in cattle that the condition will be met with by the meat inspector, and in them only in the first four years of life. Some authorities state that it does not occur until animals are one year old, while others give five months as the earliest age of the affection. Sheep and goats are also liable to black-quarter, and cases are said to have occurred in pigs and horses, though most authorities regard swine as immune. The characteristics of the bacillus which causes the disease are described elsewhere (*see* Bacteriology).

Nature of the Swelling. In a case such as that illustrated in the photograph reproduced (from a case of blackleg during 1909, kindly sent by Mr. Roberts, M.R.C.V.S., of Chepstow), there is typically observed one large local lesion on the quarter as is here seen. This is in the nature of a large swelling which is frequently necrotic. The swelling is due partly to the gases produced in the tissues which give rise to a crackling sensation on feeling the mass, and partly to a copious exudation of blood-stained serum into the subcutaneous tissue and the muscles of the part. If such a swelling be cut into it is found to be almost black in colour, with a peculiar and characteristic odour, which is, however, not that of putrescence, but which is described as being either rancid or stale. The muscular tissue in the region affected is extremely dark brown or black in colour, and the fibres show a condition of hyaline degeneration. The rest of the muscles of the body may be unaffected, and, indeed, the only other lesions to be found may consist of cloudy swelling and some congestion of the liver and kidneys, together with some minute hæmorrhages on the serous membranes.

Diagnosis. The condition with which black-quarter is most likely to be confused is that of malignant œdema, in which, however, after necrosis has taken place, there is a distinct smell of decomposing tissues. Bacteriologically the organisms of the two tissues are distinguished by the relative positions of the spores and by the fact that those of black-quarter are thinner than those of malignant œdema (*see* Bacteriology, p. 1085). There should be no difficulty in distinguishing black-quarter from anthrax, the presence of the local tumour in the former and the enlarged condition of the spleen in the latter being characteristic. Here again, too, the organisms are quite distinct.

Judgment of Meat. In striking contrast to anthrax we have to deal in black-quarter with a condition to which man is fortunately immune. There is not the slightest doubt that the meat of animals suffering from this disease has frequently been consumed without any disastrous results. It is nevertheless one of those conditions in which the carcase should be entirely condemned, the reason being—as in so many other cases—not that the disease is communicable, but that the flesh of the carcase undergoes rapid decomposition and quickly becomes totally unfit for human food. Moreover, the taste is said to be extremely rancid, and is described by Kitt as resembling that of smoked herring. The points above noted will prevent the meat inspector making the error of passing a carcase

of black-quarter for that of an animal which has received a contusion or other traumatic injury.

Doubtful Cases of Septicæmic Nature. Every now and then cases are brought into the slaughterhouse to be dressed of animals which have died immediately before. The owner generally makes an attempt to bleed them, but the dark colour of the flesh and the amount of blood in the tissues gives ample evidence of imperfection of bleeding. These cases are of many kinds, perhaps most commonly acute inflammation of the abdominal contents or acute septicæmias. Plate XV. gives a common appearance of a carcase of this sort, in which the great congestion is obvious. There were considerable redness and congestion of the intestines, acutely congested lungs, liver, and kidneys, and immense dilatation of the heart. Another point, very characteristic of septicæmic conditions in general, was present in this case, namely, the numerous minute ecchymoses and petechial hæmorrhages which occur all over the body.

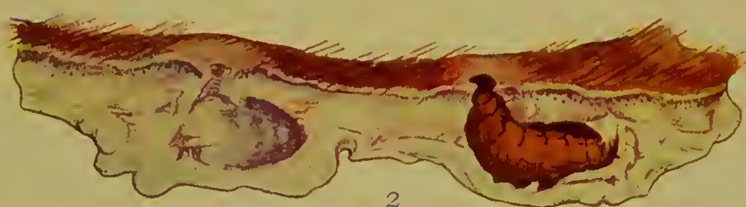
The judgment of the inspector in these cases admits of no hesitation ; the whole carcase must be condemned. It is badly bled or not bled at all, soft, flabby, and wet. It, therefore, does not set well if at all, nor will it keep good for any length of time. Probably many putrefactive organisms are already present, and if not the condition of the carcase renders their development extremely easy and rapid.

HYPODERMA BOVIS

The Ox Warble Fly

1. Upper surface of skin of ox, showing warble-holes.
2. Section through hide of ox, showing empty warble and larva *in situ*.
3. Under side of skin, showing the nodules due to presence of parasite, and parasites *in situ*.

1



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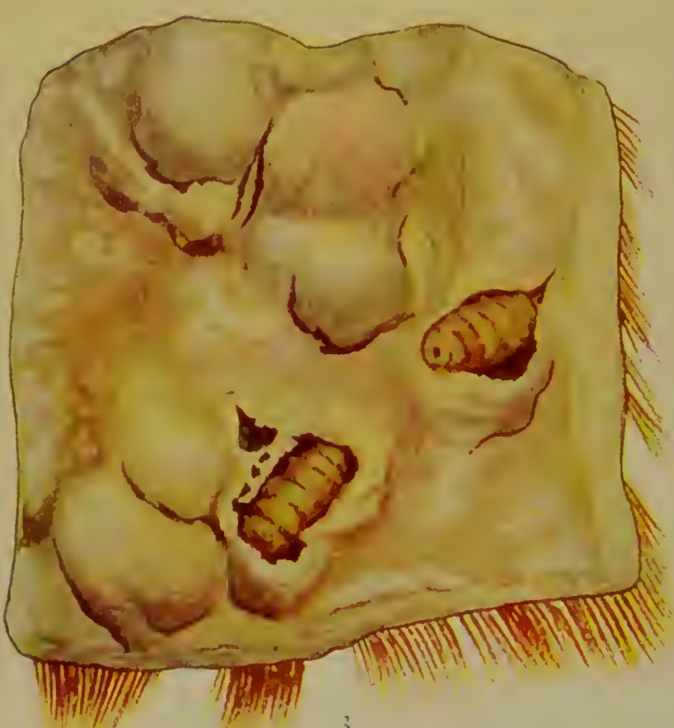


3

CHAPTER X

PARASITES IN MEAT INSPECTION

THE subject of the parasitology of the domesticated animals is an immense one and is being added to largely every year, but its strict application to our special aspect of those animals, namely, their inspection as meat, is not so extensive. We, therefore, do not propose to describe in detail all the great variety of species of parasites, descriptions which can be referred to in any standard works, but to confine our remarks to those which the meat inspector principally encounters. These divide themselves into two groups, if regarded from the point of view of their distribution in the carcase. First, we have those which are found in the skin or on it, and secondly, those which attack the internal organs. Of the former we shall only notice in detail the bots or warbles, which are important from their deteriorating effects upon the hides, and the bots of the sheep's head. Of the latter, the most important aspect for the inspector is the morbid anatomical result upon the organs which these parasites produce in their cystic stages. These are dealt with and in many cases illustrated under the various respective organs themselves (*see* lung, liver, &c.). In the case of trichinosis the details will be found in the section on Diseases of Swine (*see* p. 253, Vol. I.).

The fact that the skins of the meat animals, with the exception of that of pigs, are not used for human food, minimises much the importance of the external parasites. Other parasites are not transmissible to man, some may be transmitted by eating the infected meat, and others only after life in an intermediate host. The chief importance is the injury to various organs used as food.

Three varieties of bots are well known in connection with domesticated animals—the stomach bot of the horse, with which we have nothing to do in this work, the warble or skin-bot of the ox, and the bot of sheep. The two latter demand some notice.

The Ox Warble Fly (*Hypoderma bovis*, De Geer). The life-history of this species is thus described by Professor R. S. McDougall, M.A., D.Sc., in the *Royal* (*Dick*) *College Magazine* (February 1909). The coloured plate of the ox warble is drawn from a specimen kindly lent to the writer by Professor McDougall.

"This two-winged fly measures over half an inch in length. The colour is black, a hairy pubescence over all; the face is yellowish; the front part of the thorax has yellow hairs, the hind part black. The hairs on the abdomen are white in front, black in the middle and orange at the tip. The wings are brown, the balancers dark brown with white

scales. The legs are dark, with the feet paler. The female fly has an ovipositor, which is telescope-like, being made up of several pieces jointed into one another; this ovipositor is not fitted for piercing, When the ovipositor is extended for egg-laying the eggs pass out between three hair-like projections of the last joint.

"The egg measures 1¼ mm. It is longish oval and has a dark-coloured grooved appendage or stalk fitted for clasping the hair on which the egg is laid.

"The larva is a legless maggot, which varies in shape and external appearance according to its stage (instar). From analogy with allied species of similar habits, it is likely that there are four larval stages, although only three seem to have been described.

"In the first stage * the maggot is worm-like and up to ¼ in. long; there are twelve segments to the body, and the head is provided with horny mouth parts; this larva also shows a series of transverse bands—alternately narrow and broad—or rows of small spines.

"The second stage of the larva has not, as far as I know, been described for *H. bovis*, although it has for the allied species, *Hypoderma lineata*.

"The third stage of the larva has been figured by Joly and described by Brauer † and by Miss Ormerod. Brauer describes it as 13 mm. long and 4 mm. wide at the fourth joint. It is no longer worm-like, but is now spindle-shaped. On the under surface are rows of prickles, but on the upper surface prickles are found only on the second and third joints. There are two tube-like spiracles at the posterior extremity, with hard tips that show a number of discs.

"In the fourth stage the larva varies from 22 mm. to 28 mm. in length, and is compressed oval in shape; it has a wrinkled, rough exterior. 'The skin has become greatly thickened, and a powerful coat of subcutaneous muscles is developed. The prickles are much larger and more numerous than in the previous instars; they are arranged for the most part in an anterior and posterior transverse series on the second to the eighth segments; they are wanting from the dorsal surface of the ninth segment, and are completely absent from the tenth and eleventh segments.' ‡ After the moult which has been succeeded by this fourth stage the posterior spiracles show two kidney-shaped structures.

"The pupa is black in external covering and oval in shape.

"The two related species, *H. bovis* and *H. lineata*, have been contrasted thus:

" *H. bovis*. ⅝-inch long.	" *H. lineata*. ½-in. long.
" Prothorax densely covered with yellow hairs and the central part is black and shining.	" Nearly the whole thorax is covered with black and white hairs; there are four smooth longitudinal lines, from which lineata gets its name.

* *See* "Life Histories of the Ox Warble Flies." By A. D. Imms, B.Sc., in *Journal of Economic Biology*, 1906, Vol. I. Part 2; and Miss Ormerod's Report for the year 1894.

† "Minographie der Oestriden," 1863. By F. Brauer.

‡ Imms in *Journal of Economic Biology*, 1906, Vol. I. Part 2, p. 5.

" Hairs at end of abdomen reddish orange.	" Hairs at end of abdomen lemon-yellow.

" The differences in the egg are very slight, but there may be mentioned :

" The appendage or stalk of the egg shorter and broader.	" The stalk of the egg longer and narrower.
" Full-grown larva measures $1\frac{1}{8}$ in.	" Full-grown larva measures less than 1 in.
" The joint in front of the one that carries the posterior spiracles is without spines.	" The joint in front of the one that carries the posterior spiracles has spines on it.
" The joint second from the one that carries the posterior spiracles has spines on its lower surface but none on the upper surface."	" The joint second from the one that carries the posterior spiracles has spines both on its upper and lower surface."

Life-history of H. Bovis. " The eggs are laid on the hairs. From the habit of dressing the back with some fly deterrent, the common belief is shown to be that the eggs are laid on the hairs of the back and near the shoulders.

" The larva on hatching eats its way through the skin, making a fine passage to the subcutaneous tissue to work its way upwards again later on. In this later movement upwards to reach the air the old passage and entrance-hole are widened. In this movement the larva moves tail foremost, and uses for enlarging the passage the hard edges of the breathing pores at the end of its body. Now, in the later stages and until its growth is complete, the larva, still with tail end nearest the external opening, lies in the cell or cavity known as the warble. Brauer states that in this position the prickles are brought into play by muscular effort, and that the consequent movement of the larva induces by its irritation a secretion of pus on which the maggot nourishes itself.

" When the maggot is full grown it—by the aid of the prickles—squeezes itself out of the external pore, as a rule, early in the morning, and falls to the ground for pupation. The pupal stage lasts, according to Miss Ormerod, twenty-five to twenty-six days. In Carpenter's experiments the pupal stage lasted six to eight weeks in summer.

" The fly is commonest from midsummer to the end of July, but emergence of flies probably takes place over a more extended period of time. According to trade reports there are few warbled hides from September to February. The time for warbled hides is February to September, and in this time chiefly April and May.

" In view of recent work on the Continent, and as a result of recent experiment by Professor Carpenter in Ireland, the life-history as given above cannot be accepted definitely—there are at least other possibilities.

" With regard to place of egg-laying by the female fly, Carpenter,*

* " The Warble Fly : Experiments on Cattle as to its Treatment and Life-history." By Professor George H. Carpenter and J. W. Steen. P. 8.

as a result of experiments with beasts kept under conditions of control, is of the opinion that 'the eggs are laid chiefly on the legs, not on the back. The fly strikes both at the fore and the hind limbs near the hock; more rarely on or behind the shoulder. Very seldom indeed was the fly observed to approach the back or the ribs of the cattle. Most of the observations were made during the month of August, when the flies seem to be most numerous and troublesome. Many days were spent watching the cattle in an enclosure, and also tied to stakes in an open field.'

"In the summer of 1904, in Carpenter's experiments, four calves were kept from May 30 till September 12 with their backs covered, so that 'the skin from front of shoulder to rump' was completely protected. On examination in April 1905 these calves showed two, five, fourteen, and nine warbles respectively.

"In 1905 * four calves kept covered on back and sides from June to September showed in March to May 1906, nine, eighteen, six, and seven warbles respectively.

"One calf kept completely clothed from June to September showed no warbles at all.

"Four calves with legs covered from June to September (these calves, however, were uncomfortable in their improvised leggings and trousers, which were now and again worked off, so that the legs were on occasion exposed) showed three, three, four, and four warbles respectively. Carpenter and Steen believe that the smaller number of warbles in this last case as compared with the first was due to the 'imperfect and discontinuous protection of the calves' legs.'"

The Hypoderma Bovis. "In the life-history given,† it was assumed that the larvæ on hatching gnawed their way directly into the skin, taking up at once the position in which they are found at the end of their growth. This, however, has not been proved beyond doubt, and there is a considerable body of opinion that the larval habit may be different. In the closely allied species, *Hypoderma lineata*, where the larvæ are in their last stage, found in the characteristic warble-cells below the skin of the back, it is believed that the larva in this case is first of all taken in at the mouth (the eggs are laid on the legs just above the hoofs) and reaches the gullet; that then, after boring into the gullet and through other tissues, it reaches, after a process of wandering, its final position under the skin.

"It has been suggested that the same may take place in the case of *Hypoderma bovis*. Jost ‡ could not find the young larvæ of *Hypoderma bovis* in the skin of cattle, but he found them in the lower part of the gullet and the first part of the stomach. Jost believes that the cattle lick off the eggs from the hairs on which they have been laid, and that the maggots hatch in the host's alimentary canal.

"Imms‡ has summarised the observations of Ruser, Horne, Hinrichsen,

* Carpenter and J. W. Steen, p. 16.

† "Beitrage zur Kenntnis des Entwicklungsganges der Larve von Hypoderma bovis. *Zeits. f. inssens Zoolog.*, Vol. LXXXV., 1907, pp. 644–715.

‡ "On the Life-histories of the Ox Warble Flies." By A. B. Imms, B.Sc., London.

and Koorevaar, veterinary surgeons in Holland, and the evidence is in favour of the wandering theory. Thus Ruser, in 1896, found that four oxen with warbles in their skin had also transparent larvæ in the wall of the œsophagus. Ruser believes that the larvæ bore their way through the œsophagus, wandering by way of the ' great vascular trunks and nerves of the neck to the sub-cutis of the back,' and that ' some also find their way through the inter-vertebral spaces into the spinal canal.'

" Hinrichsen, in 1888, in an examination of the carcases of twenty-five oxen, found in ten of them small larvæ ' lying between the periosteum and the dura mater of the spinal cord,' these being regarded by him as probably *Hypoderma bovis* larvæ in the first stage. Horne also found the larvæ in the spinal canal."

Larvæ in Slaughtered Cattle. " In 1898, Koorevaar, in the months of January, February, and March, frequently got larvæ in slaughtered cattle ' under the skin in numbers, and in the spinal canal of the same animals. Neither in size nor in form did the largest spinal larvæ differ from the youngest of the larvæ found under the skin. In frequent instances larvæ were found to have crawled out of the spinal canal, and were lying in the inter-vertebral spaces, and, in one case, a larva was found lying between the neural spines. On February 28 a yearling beast was found with many larvæ beneath the skin, and it had three in the spinal canal, and thirteen were found embedded in the connective tissue of the œsophagus, between the mucosa and muscularis layers of the latter. The œsophageal larvæ were in all respects similar to those found in the walls of the gullet on two occasions afterwards. On one occasion Koorevaar inserted eleven spinal larvæ from a calf beneath the skin in the left lumbar region of a small dog. The experiment was performed under antiseptic precautions, and the incision soon healed. Eight days later, in the same manner, fifteen more of the larvæ were introduced under the skin of the right side. A period of fourteen days was allowed to elapse, and then the dog, which remained quite normal, was dissected. Five of the larvæ were found still beneath the skin, and of these, one was found in the left costal wall, one in front of the shoulder, one in the right thigh, one in the skull and a fifth on the jaw. Six of the larvæ were found lying free in the peritoneal cavity between the folds of the intestine, and a further five were discovered in the fat of the spleen, kidneys, omentum, inguinal canal and the retroperitoneal tissue respectively. On removing the kidneys three were found on the psoas muscles, and three more were met with in the wall of the œsophagus, two others in the peritracheal tissue, and two in the spinal canal between the dura mater and the periosteum. Thus, all the twenty-six larvæ are accounted for, and they were for the most part alive. It is noteworthy that the wanderings should have taken place in so short a time after they had been introduced under the skin. No tracks or traces of their migrations could be detected in any part of the animal, in spite of careful examination.' *

* Koorevaar, quoted by Imms on page 7 of " On the Life-histories of the Ox Warble Flies," *Journal of Economic Biology*, 1906, Vol. I. Part 2.

"Imms also quotes T. P. Koch * as having found 'the larvæ abundantly, both in the walls of the œsophagus and under the skin. In the case of those in the gullet, they were found as early as July, when they measured only 2 mm. long.' Koch found these larvæ in the gullet on till March, and in the months January to March he also found the larvæ plentiful in the spinal canal.

"It is difficult to withstand this body of evidence in support of the wandering theory. The possibilities are :

"*1st.* That the larvæ hatch from eggs laid on the hair, and bore directly into the skin of the back, wandering scarcely, if at all, in the sub-cutis, and giving rise *in situ* to the characteristic warbles.

"*2nd.* That the larvæ hatch from eggs laid on the hairs, and that they bore through the skin, and that then they may wander through the tissues, *e.g.*, to the œsophagus or to the spinal canal, or to both, taking up their position at last below the skin in the warbles. Carpenter leans to this view, believing that the larvæ enter, not by way of the mouth, but through the skin.† Six calves were taken in 1906, and were muzzled with leather or basket muzzles, so that they could neither lick themselves nor their neighbours. In the daytime these calves were turned out in the fields. 'At night the necks of the calves were tied between specially constructed stakes, and their fore limbs were clothed with leggings, so that, while they could feed, they were unable to lick themselves. The leggings may have occasionally slipped off, but they were used only as an extra safeguard, the position of the animal, when tied, preventing any part of the body except the hoof being brought within reach of the tongue.' This muzzling and tying was continued till November. Five out of these six calves showed warbles in March to May 1907, the numbers being sixteen, twelve, twenty-seven, twenty-seven, ten. This experiment would seem to indicate that entrance by the mouth for the larvæ is, at least, not absolutely necessary.

"*3rd.* That the larvæ hatch from eggs laid on the hairs, but that they are licked up and reach the gullet, and are found later on, after a process of wandering, below the skin.

"*4th.* That the eggs are licked off the hairs, and that the larvæ hatch out in the gullet, or lower down in the alimentary canal."

Bots in Sheep. These larvæ of the *Œstrus ovis* are found in the frontal sinuses and horncores of the head of the sheep. The frequency of occurrence varies much in different parts of the world and in different districts, but it has been shown in various places, parts of Australia for instance, that the bots have become widespread. In order to give information concerning this parasite to the sheep-owners, the Agricultural Department of New South Wales issued a leaflet on the subject, from which we quote the following particulars. Our illustrations of the bots are from the *New South Wales Agricultural Gazette*, by permission of that Government.

* Abstract of T. P. Koch's Paper in *Centralb. f. Bakter Parisiteuk*, 1904, Bd. 34, p. 723.

† Carpenter and Steen, p. 17.

"A report was published in the *Agricultural Gazette*, in December 1901, drawing attention to 'bots' (or larvæ of the *Œstrus ovis*) being found in the frontal sinuses and horncores of the head of a sheep, upon which a *post-mortem* examination was being made. The infestation of sheep by these parasites was described as being of a very rare occurrence in this State, as the case referred to was, it is believed, the first of its kind reported. Since then the *Œstrus ovis* has become so widespread in the eastern and central districts that, of late, numerous inquiries have been received as to the exact nature of the 'grubs' found in the heads of sheep, and as to whether they have any connection with the various ailments the sheep in which they were found, suffered.

"In order to bring the exact nature of this affection within the purview of sheep-owners, the following information is published:

"The *Œstrus ovis*, Linn. (*Cephalomyia ovis*, Latreille),* is a small fly of greyish yellow hue and slightly hairy, face yellow, buccal pieces testaceous. Upper surface of the thorax of a brownish grey, granular and streaked by obscure or nebulous lines. Abdomen marbled and spotted with white, yellow and black, covered with fine hairs behind, having a silky hue, wings hyaline and transparent, marked at their base by three black points. Length of body, about one-half to three-quarters of an inch."

The Species throughout Europe. "The species is very widespread, being found throughout Europe, in Asia, Africa, the Canary Islands and the two Americas. Like other *Œstridæ*, it lives in the perfect state during warm weather. It hides in the holes and crevices of fences and walls of sheep-folds, which it leaves when coupling-time has arrived and the temperature is sufficiently high. The fecundated female now goes in search of sheep, which are afraid of its approach and huddle together in a dense pack with heads down. The sheep on the outside of the pack become greatly agitated, and rub their noses in the dust between their fore feet. According to Bracy Clark † they raise clouds of dust to deceive their assailants. As a sheep falls a victim, he generally breaks away from the rest of the flock at a gallop, holding his head towards the ground, often shaking it, snorting violently and stamping furiously, in getting rid of his adversary. The nostril of the sheep becomes very sore and inflamed from the repeated attacks of the fly and from rubbing on the ground.

"The fly, taking advantage of a favourable opportunity, deposits its eggs on or near the nostrils of the sheep. In a few days the eggs are hatched, and the young larvæ (scarcely visible to the naked eye) crawl into the nostrils, aided by means of two hooklets, and commence to feed on the mucus. In due course, they pass up the nasal chambers and gain the sinuses of the head, where they develop.

"The young bots are of a white colour and transparent, but become darker with age. The adult bot is somewhat larger than the 'stomach bot' of the horse, but smaller than the 'warble bot' of the ox (*vide*

* Neumann's "Parasites." † Steel, "On Sheep."

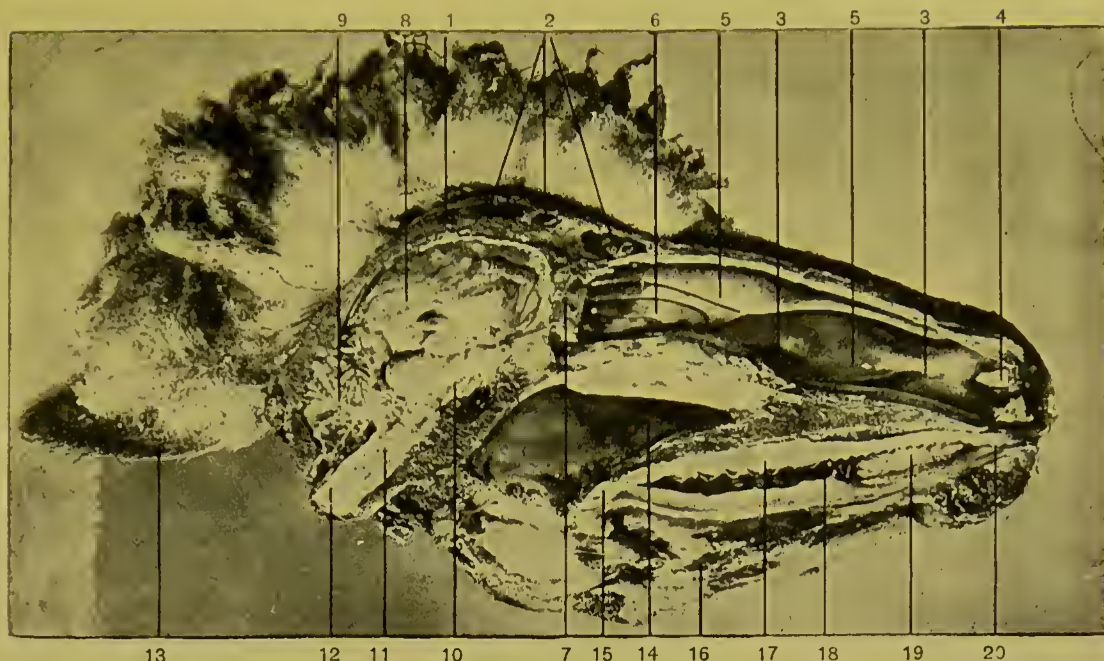
Figs. 2 and 3), being from 1 in. to 1¼ in. long, and one-third its length broad. It has a grub-like appearance, and has two brown patches or chitinous plates enclosed in a fleshy ring at its posterior extremity."

Movements of the Bot. "The bot or larva remains about ten months in the cavities of the sheep's head. Having attained complete maturity, it leaves its abode, passes into the nose, and is expelled through the nostril during one of the violent fits of snorting its presence excites. Twenty-four hours after its exit, it is transformed into a nymph, and the shell, which was at first soft and red, is now brown, then black, its upper surface being convex and the lower concave. The duration of the nymphosis is from a month to six weeks, when the issue of the perfect insect, or fly, occurs, and a new life-cycle begins.

"Opinions differ as to the severity of the effects of bots in sheep. Youatt and Clark minimise them; others attribute many fatalities to their presence, especially during the spring of the year. Even the occurrence of septic meningitis has been ascribed to them. It is, however, usual to find three or four larvæ in the frontal sinuses, which during life have given no indication of their presence. Most veterinary authorities agree that, as a rule, they rarely occasion any morbid disturbance, unless they are very numerous and advanced in development at the commencement of spring. The first sign of their presence is a discharge of mucus, often from one nostril only, at first clear and serous, but becoming turbid and thick. This condition is known as parasitic nasal 'catarrh' or 'ozœna.' There is frequent sneezing and snorting, accompanied by expulsion of mucus, often blood-stained. The sheep lose condition, have irregular movements, and twist their heads occasionally as if in pain, symptoms which have led to this affection being mistaken for 'sturdy' or 'gid,' caused by a hydatid (*Cœnurus cerebralis*) on the brain."

Preventive Methods. "A number of preventive methods are practised to protect sheep from the attacks of the fly. A very old practice is that of turning up a few furrows in the paddock where the sheep are depastured, so that they may follow their natural instincts and bury their muzzles in the soil. The smearing of the sheep's noses with empyreumatic oils, or tar, is also carried out, but this is a tedious operation when large flocks have to be treated, and, at best, is one of ephemeral advantage only. A more satisfactory method is that suggested by Walker, which is to place a supply of Liverpool salt in long troughs, covered by lids perforated by holes about two inches in diameter, the margins of which are smeared with tar, or some other repellent substance, so that when the sheep take the salt their muzzles are automatically dressed.

"Many kinds of treatment have been made known, but few have yielded satisfactory results. Among those most commonly practised are (1) the blowing of tobacco smoke from the tail end of a pipe up the nose; (2) the fumigation with fumes of burning tar and sulphur in a suitable building; (3) the injection of a mixture of turpentine, ether and oil; (4) trephining the skull and removing the infesting bots surgically."



Photographed by R. GRANT, *Health Dept.*

Fig. 1. Hemi section of Sheep's Head.

1. Sinus leading to that of horn-core.
2. Frontal sinus, showing "bot" in common position.
3. Nasal passage.
   (No. 1 communicates with No. 2; No. 2 with No. 3.)
4. Opening of nostril leading into nasal passage.
5. The turbinated bones.
6. The lateral masses of the ethmoid.
7. Cribiform plate of the ethmoid bone, dividing the nasal from the cranial cavity.
8. The cerebrum.
9. Cerebellum, showing the arbor vitæ.
10. Base of brain.
11. Medulla oblongata.
12. Portion of spinal cord.
13. The external ear.
14. Posterior nares.
15. Soft palate.
16. Lower jaw.
17. Cavity of the mouth.
18. Molar teeth.
19. Papillæ on inside of cheek.
20. The mouth.

Fig. 2.
Group of Bots removed from head of Sheep.

(Natural size.)

Fig. 3.
Three Bots of Domesticated Animals (ventral aspect).

A The warble (or skin) bot of the ox.
B The bot of sheep.
C The stomach bot of the horse

Bots in Sheep.

Worms and Human Infection. The following excellent short summary of verminous parasites and human infection is given by Ostertag :

" Among both groups of flat and round worms the following parasites are not transmissible to man :

" (*a*) All tape-worms of the food animals, with the single exception of *Tænia echinococcus* of the dog.

" (*b*) The larval stages of all tape-worms of food animals, with the exception of *Cysticercus bovis*, *C. cellulosæ*, and *Echinococcus polymorphus*.

" (*c*) All fluke-worms (trematodes).

" (*d*) All nematodes (*Ascaris*, *Eustrongylas*, *Filaria*, *Oxyuris*, *Strongylus*, *Trichocephalus*, and *Acanthocephali*), with the single exception of *Trichina spiralis*."

We may therefore restrict our attention to those which are transmissible, or whose results to organs render the latter unfit for food.

Tænia echinococcus. A tape-worm of only four segments, not more that $\frac{1}{4}$ to $\frac{1}{2}$ in. long, living its adult life in the small intestine of the dog and wolf. The last segment only reaches sexual maturity, and produces all the eggs.

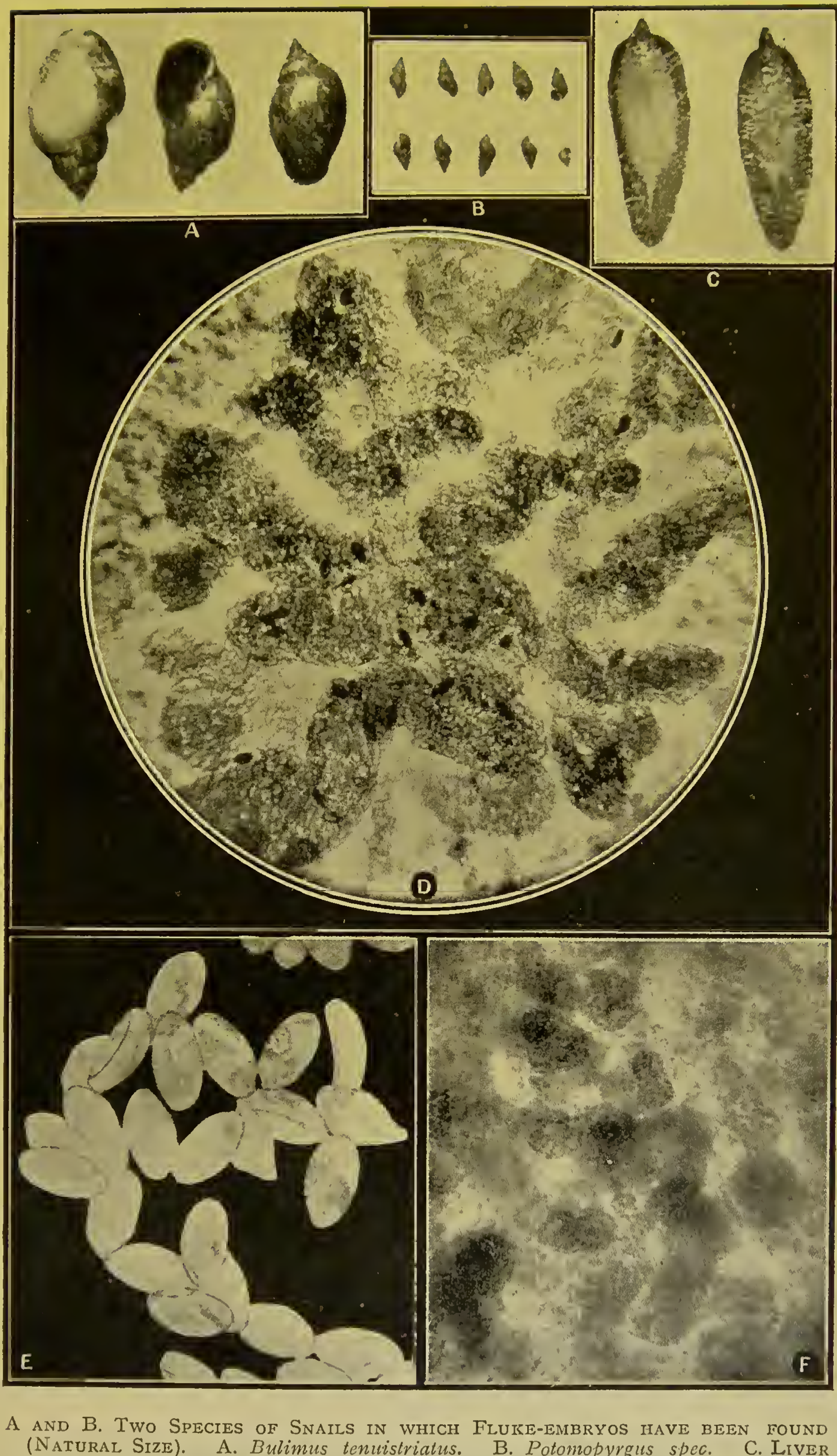
Echinococcus polymorphus is not uncommon in sheep, cattle, and pigs, the cysts occurring in the liver, lungs, or spleen usually. In cattle the lungs suffer more than the liver.

Cysticercus bovis. This, the beef-bladder worm, is the larval stage of the tape-worm, *Tænia saginata*, of man. In the meat animals the common seat is the masticatory muscles of cattle, which in many continental countries are systematically examined for its presence. In these muscles the cyst may be as large as a pea. It may also occur in the heart and tongue. Dr. Robertson, M.O.H., of Leith, states that in his opinion this should be carefully looked for in this country, since as the result of the adoption of the raw-meat treatment for consumption he has found patients infected with the tape-worm (*see also* Special Organs).

Cysticercus cellulosæ. This, the hog-bladder worm, is the larval stage of the thin *Tænia solium* of man. Infection is prevented by thorough boiling of the pork, and hence is not very common in this country. It takes its name of " cellulosæ " from the fact that it occurs in intermuscular connective tissue, and is said not to be killed by cold storage.

The infections in cattle and pigs of *Cysticercus bovis* and *Cysticercus cellulosæ* give rise to the terms " measly beef " and " measly pork " respectively.

The Liver-fluke. Of all the parasitic diseases which are seen by the inspector and whose effects lead to seizure of organs, possibly the liver-fluke is the most common. The parasite is very widespread in the world, and in some countries is so bad as to practically preclude the possibility of growing sheep profitably. It is extremely common in some districts of Australia, which has caused inspectors there to devote much attention to the parasite and its results. One of the best accounts of these is that by Dr. A. A. Brown in the *Agricultural Journal of Victoria*, which we quote by permission of the Victorian Government. It applies equally



A and B. Two Species of Snails in which Fluke-embryos have been found (Natural Size). A. *Bulimus tenuistriatus.* B. *Potomopyrgus spec.* C. Liver Fluke (*Distomum hepaticum*), Natural Size. D. Female Organs of Reproduction × 36 Diameters. E. Eggs of Fluke × 100 Diameters. F. Male Organs of Reproduction × 100 Diameters

(By permission of Victorian Government.)

to our own country, with the exception of the species of snails which afford the intermediate host. In Britain this *rôle* is played by *Limnæa truncatula*. The references to possible means of treatment and prevention will be read with interest by sheep-breeders in this country.

LIVER ROT OR FLUKE

Description and Life-history of Flukes infesting Sheep. "Trematodes or flukes in the adult state, and as they occur in the bile passages of the liver (bile-ducts, ductus choledochus communis and gall-bladder), are small flat-shaped creatures, usually pointed at each end and not divided into segments. A fluke has much the shape of a flounder. They are provided with two sucking-discs, one situated at the mouth (oral sucker) and the other on the abdomen (ventral sucker). The ventral sucker is placed a short distance behind the oral sucker. Flukes possess a mouth opening into a tube (œsophagus), which communicates with a bifurcating alimentary canal that has no posterior opening, and which is hollowed out in the substance of the body. The animals are hermaphrodite—male and female reproductive organs existing in the same individual, and occupying a great part of the body. The oviduct of a single individual may contain as many as 40,000 eggs.

"Two varieties of fluke infest the sheep.

"(1) The *Fasciola hepaticum*, or *Distomum hepaticum*, is the common variety found. The worm varies from eight to fourteen lines in length, and from two to six lines in breadth, and is about $\frac{1}{16}$th of an inch in thickness. The eggs, which are of a brownish colour, are about $\frac{1}{200}$th of an inch in length, and the young fluke, as it first invades the liver, is about $\frac{1}{24}$th of an inch in length.

"(2) The *Distomum lanceolatum*, which is not often encountered, is about four lines in length and about one and a half lines in breadth."

How the Egg develops. "Flukes, which have somewhat the colour of the liver they infest, lay their eggs in the bile-ducts, and ultimately the eggs escape from the liver and from the intestines of the sheep and gain the outside world. The further development of the egg depends on certain conditions being fulfilled. First, it must gain water. If it does not gain water it dries up and perishes. In water the envelope surrounding the egg ruptures, and the embryo is released. This first stage of existence is the free-swimming stage. In this stage the embryo is ciliated, and it swims about in the water into which the eggs were cast. It now cannot undergo further development unless it gets into the body of a snail. The free-swimming embryo, as it swims about, eventually comes into contact with the body of a snail, and it invades it. Even indeed here, thus far, it is not quite safe, for unless it gets into the lung chamber of the snail it cannot undergo further development.

"The embryos of fluke may sojourn in all our fresh-water snails, and

in numerous species of snails the embryos have been found. In different species—*Ancylus*, *Bulimus*, *Planorbis*, *Segmentina*, *Limnæa*, *Potomopyrgus*—they can, at the proper season, always be found. The snail is invaded in August, September, and October, and the embryos that are lucky enough to reach the lung chamber undergo further development. In the lung chamber the free-swimming embryo develops to the sporocyst stage. A sporocyst has the form of a bag, and there may be several generations of sporocysts. Eventually, however, the sporocysts give rise to *Rediæ*, which are sac-like structures. Each *Redia* may be $\frac{1}{12}$th of an inch in length. The *Rediæ* give rise, in the end, to the *Cercariæ*, or tailed forms. *Cercariæ* are really young flukes, having a tadpole appearance, and are found free in the lung chamber of the snail in December, January, and February. Starting with a single free-swimming form, we may have many hundreds, perhaps thousands, of cercariæ developed from it."

The Methods of the Fluke. "In time the *Cercariæ* escape from the body of the snail into the water in which the snail lives. They are then carried by the water over low-lying lands, and, when opportunities occur, they attach themselves to blades of grass. Here they throw off their tails and encyst themselves, that is, form a protective covering for themselves, and wait for the sheep to devour the grass on which they are fixed. They are found encysted on the grasses from February to May in Victoria.

"Sheep grazing over places where grasses on which encysted *Cercariæ* abound become infested with fluke. In the stomach of the sheep the protecting envelope is digested, and the young fluke set free. It now finds its way to the liver, and becomes sexually mature.

"There is in the life-history of the fluke a distinct alternation of generations.

"(1) There is the adult fluke which produces embryos sexually.

"(2) The young stages—*Sporocyst* and *Redia* stages—each of which can give rise to new forms asexually.

"Thus it can be seen that sheep cannot directly convey the disease to other sheep, as another animal (snail) must take part in the development. This round in the development must occur to perpetuate fluke, and to combat fluke certain steps are capable of practical adoption."

Symptoms of Liver Rot. "The disease is usually insidious in its onset and chronic in its progress. Sheep affected with fluke in the liver in excess are noticed to be listless and weak. Their faces and also their conjunctivæ are pale. (The conjunctiva is the mucous membrane which covers the external surface of the ball of the eye and the inner surface of the lids, and in a healthy sheep it is of a bright red colour.) There may be a running from the eyes and nose, and the discharge may be of a muco-purulent character. The mucous membrane of the mouth takes on a livid hue. In some cases the bowels are very irregular, and diarrhœa may be a prominent feature. The wool readily pulls out, and usually there is an œdematous swelling, having a bottle shape, under the jaws. In some cases there may be a pendulous condition of the belly. The

affected sheep soon fall away in condition, and eventually are reduced to skin and bone. They die, in the end, of exhaustion, death being preceded by coma. After death the carcases rapidly swell up and decompose, emitting a sickening smell. This early putrefactive change is a circumstance associated with 'rot.'

"When the *Cercariæ* (young fluke) invade the system in December, January, and February, the complaint cannot be diagnosed unless enormous invasion of the liver takes place. By invading the liver in enormous numbers young fluke may bring about acute congestion of the organ and death. Microscopic examination might then lead to the detection in the bile of the young fluke, and early solution of the cause of the fatalities."

Pathology. "The post-mortem appearances presented in many cases examined by me have been of a fairly uniform character, and the following morbid changes may be observed:

"On skinning an animal dead of the disease it is found that the skin is easily removed from the carcase, and that its under surface has a pale appearance. The carcase is devoid of subcutaneous fat and is very emaciated, and it has a decidedly pale appearance and is œdematous. The œdema is noticed particularly along dependent parts in the region of the thighs, chest, and neck. On cutting through the abdominal and chest walls the belly and thorax may be seen to contain large quantities of serous fluid. The blood is noticed to be thin and watery, and if collected in capillary tubes it soon separates out into serum and clot, the clot being very small. The serous effusion is clear and limpid, and has a specific gravity of 1005.

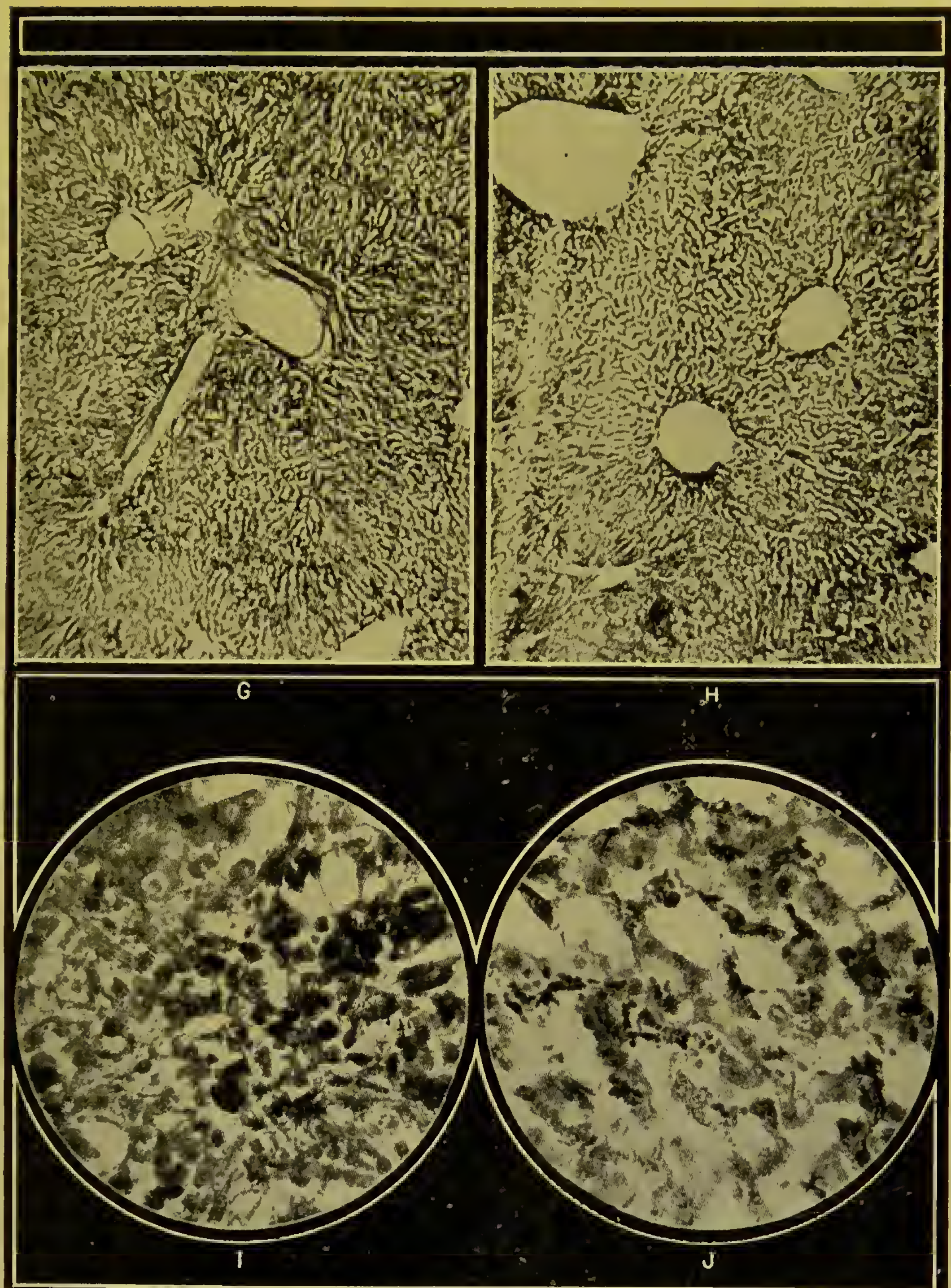
"*Lungs.* As a rule the lungs are pale in colour, and the lining membrane of the chest is smooth and displays no traces of inflammation. Sometimes, however, the lungs may show patches of catarrhal pneumonia. Cross-sections of the lungs are usually pale and flabby, and a frothy fluid can be expressed from the cut surfaces. The bronchial tubes, the mucous membrane of which is thickened, usually contain a mucopurulent secretion.

"*Heart.* The pericardium, or heart sac, may contain a serous exudation (hydropericardium). In the cavities of the heart firm clots in serum may be found. The substance of the organ is pale, soft, and flabby, and easily torn. Sometimes ecchymoses may be present on the endocardium.

"*Blood.* The blood is hydræmic or watery.

"*Liver.* Flukes inhabit the bile-ducts in the liver, where, if in considerable numbers, they set up great irritation and distend the bile passages. In the remote ramifications of the bile-ducts they interfere with the relations between minute ducts, the blood-vessels and liver-cells. They, moreover, obstruct the flow of bile and consume the nutritive juices.

"Perihepatitis, or inflammation of the capsule of the liver, is a very common condition in 'rot.' The organ may be united to the omentum and to the diaphragm by inflammatory products. The capsule generally may be thickened and roughened, and have adhering to it shreds of fibrin. This condition of perihepatitis is dependent upon bacterial invasion, and



G. SECTION OF LIVER OF FLUKY SHEEP, SHOWING LOBULES INFILTRATED WITH SMALL ROUND CELLS AND FIBRILLAR TISSUE, CONSTITUTING A FINE CIRRHOSIS
× 40 diameters.

H. SECTION OF LIVER OF HEALTHY SHEEP, SHOWING LOBULES AND COLUMNS OF HEPATIC CELLS
× 40 diameters.

I. SECTION OF LIVER OF FLUKY SHEEP, SHOWING ROUND CELLS WITH NUCLEI
The normal cell elements have almost all been destroyed by the round cell invasion. × 380 diameters.

J. SECTION OF LIVER OF HEALTHY SHEEP, SHOWING POLYHEDRAL CELLS WITH DISTINCT NUCLEI
× 380 diameters.

(By permission of Victorian Government.)

the bacteria perhaps invaded the liver along with the young fluke. Having reached the organ, the germs penetrate its substance and gain its coverings, where they set up inflammation. Sometimes abscesses may be formed, but as a rule the inflammation runs a chronic course, leading to considerable thickening of the capsule.

" *Cirrhosis.* The irritation, uninterruptedly continued by the fluke, provokes a cirrhosis, or inflammation of the substance of the organ. Cirrhosis is characterised by increase in the connective-tissue elements, and by atrophy of the liver-cells. In the very early stages of infestation the organ may be considerably enlarged, possess a flesh-like consistency, and be very soft ; but, as the disease progresses, it begins to contract and become firmer. Further, the functions of the organ are deranged by the large quantity of ova and young and adult flukes that clog the biliary passages.

"At a late stage the liver may be tough from increase of connective-tissue elements, reduced in size, and its surface may be rough and have a great many nodules scattered over it. These nodules vary in size and colour. Numerous tortuous, greyish white lines and spots may also be observed on the surface. These lines and spots indicate thickening and distension of the bile-ducts, and when they are cut open numerous flukes may be expressed.

" The cut surface, on section, may have a yellowish or yellowish brown, mottled, granular appearance, and patches may be bile-stained. The gall-bladder is generally full of thick viscid bile which possesses a dark olive-green colour."

Effect of the Disease on the Liver. " As the disease progresses the liver undergoes considerable alteration in structure. The liver-cells, by the increased development of connective tissue, are pressed out of existence, for newly formed connective tissue always has a tendency to contract, and the liver thus becomes reduced in size and may be very tough. The profound structural changes wrought in the liver substance through the irritative action of the fluke lead to obstruction in the portal circulation, retardment of the flow of bile through the bile-ducts, impairment of the glycogenic function, and to alteration of the secretions and to impairment of digestion. In consequence of all these factors operating, emaciation results, and the debility, which comes on early in the course of the disorder, goes on increasing. Jaundice is usually slight, because the bile is not effectively arrested, the bile-ducts being subjected to a compression more or less uniform. The compression of the capillaries and branches of the portal vein, excited by the newly formed connective tissue, results in a sluggish flow of blood through all the abdominal organs, and, after a time, it becomes so retarded that the fluid part oozes through the walls of the vessels into the belly cavity, producing ascites—dropsy of the belly cavity.

"In consequence of all that has been said, the general circulation eventually becomes embarrassed through the power of the heart failing, and, as a result, there is effusion of fluid into the chest cavity and into

the pericardium, and into the loose tissue beneath the skin in dependent parts. The whole body in the end then becomes 'waterlogged.' This is 'water-rot.'

"In the slaughterhouse it is common to find livers, presenting great structural alterations, which had once been inhabited by flukes and from which the parasites had escaped. Such livers are firm, tough, and the bile-ducts thickened and here and there sacculated.

"*Spleen.* The spleen generally is smaller than normal, and its consistency is tougher than natural. Sometimes a few subcapsular hæmorrhagic spots may be noticed, and there may even be inflammation of the capsule with adhesions to adjacent organs.

"*Kidneys.* In advanced cases the fat enveloping the organs has entirely disappeared. The capsule peels easily, leaving a smooth surface, and a few petechiæ may be seen beneath it. The cortex has a pale yellow and the medulla a pinkish yellow tinge. The cut section is soft and opaque and the pyramids indistinct.

"*Female Generative Organs.* Œdema and even dropsy of the uterus may be present. Abortion is a common occurrence in 'rot,' and arises from the changes indicated in the organs.

"*Bladder.* The bladder may be contracted.

"*Lymphatic Glands.* The mesenteric glands may be enlarged, softened, œdematous, and pigmented. Some, indeed, may be quite black. The mediastinal, bronchial, gastric, and hepatic glands may also be enlarged, œdematous, and pigmented. The hepatic glands may be fully six times their normal size.

"*Abdominal Cavity and Other Organs thereof.* The lining membrane (peritoneum) of the abdominal cavity may be smooth, and may be quite free from inflammatory changes. The stomach and intestines generally are pale, soft, and infiltrated with serous fluid, the mucous folds of the fourth division of the stomach being much swollen. The cavity may contain a large quantity of clear fluid. In some rare cases the fluid may be dark, and there may also exist considerable pigmentation (hæmatinic) of a dark hue in the folds of the mesentery, which may also be very œdematous.

"*Brain.* The membranes may be congested, and may be readily removed from the convolutions without tearing the substance of the organ. In the subarachnoid space there may be an accumulation of a fairly large quantity of serous fluid. On section the brain substance is soft, the grey matter having a dirty grey tint, and the white matter a chalky appearance. Just beneath the pia mater, in some cases, the substance may be opaque and inclined to be diffluent.

"*Carcase.* In a well-marked case the carcase is extremely emaciated, the whole of the subcutaneous fat, the caul fat, and the fat surrounding the kidneys and deposited in other structures having entirely disappeared. The flesh is pale, soft, flabby, and watery."

Factors in Checking the Fluke. "As has already been pointed out, flukes cannot perpetuate their existence without the assistance of snails,

and all species of snails in Victoria harbour fluke embryos, so, if stock-owners could exterminate snails upon their holdings, fluke disease would be brought to an end, since, in the absence of the snails, flukes would cease to find a half-way house on their life's journey. To keep down the development of snails, lands require to be drained and dressed with salt or lime applications, and, further, to get rid of the embryonic flukes encysted on the grasses, pasture-lands require to be burnt off periodically, and then, if possible, dressed with salt or lime.

"Insectivorous birds—such as the ibis, mudlark, jackass, kingfisher, ducks (wild and tame)—should be encouraged about swampy places and crab-holey country as they devour snails. Sea-gulls, also, would devour snails, and the introduction of sea-gulls would be of advantage to keep down the numbers of snails. To keep sea-gulls on a place they would require to be pinioned.

"Frogs, toads, and crayfish feed upon snails, so they also aid in keeping their development in check. Fish generally devour snails, so in rivers and streams they carry on the crusade. The molluscan hosts must be vigorously attacked if any country is to be rendered safe from fluke outbreaks. Unusually wet seasons—a rainy summer, moist autumn, and wet winter—are favourable to the development of fluke, and where there is a long succession of wet seasons the outbreak may be very severe. Damp country, where fluke is known to prevail, is unsuitable for sheep. It comes then to be considered whether sheep husbandry on such country can be profitably continued, and, if continued, what are the steps to be taken to minimise invasion of the sheep by fluke?"

Measures that might be adopted. "In the first place, endeavour must be made to arrest the development of fluke. Nature's methods of preventing fluke becoming too numerous are droughts and frosts. Human methods must embrace extermination of the intermediary hosts, burning off the pastures whereby fluke-ova, intermediary hosts (snails), and embryo-flukes are destroyed, and draining and liming the country.

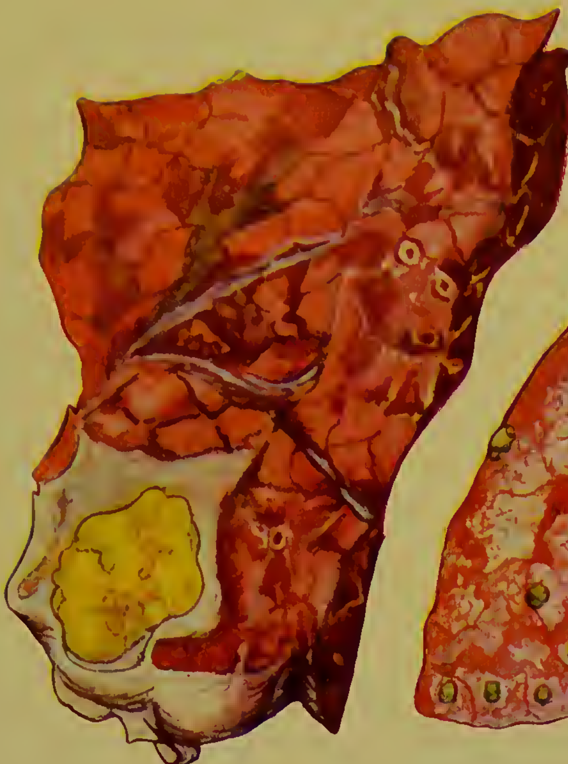
"Lands low-lying along the banks of rivers, streams and fresh-water lakes and dams, and also swampy depressions, crab-holey country and damp places generally, may be said to be liable to be infested with young flukes (*Cercariæ*), which in the early part of their existence sojourn in all varieties of fresh-water snails.

"On country where fluke is known to extensively prevail, sheep should not be grazed, so, wherever practicable, fence off such country and cultivate it, or devote it to some other purpose. In these days of cheap wire fences, damp, marshy tracts known to be unsound can be cheaply divided off.

"If the water-supply has to be drawn from sources supposed to be contaminated, pump the water into troughs and add salt to it. Water the stock from the troughs, and see that sufficient salt is added to make the water faintly saline. Very weak saline solutions (1 lb. salt to twenty-five gallons water) will kill the *Cercariæ*, and this is the stage in the course of development in which the fluke-embryos are capable of proving harmful

COMMON SPECIMENS IN ORGANS

1. A single, chronic, caseous, gritty cyst, within a fibrous capsule, from bovine lung. A common specimen, probably not tubercular, but parasitic in origin.
2. Surface of a sheep's lung, showing numerous yellowish nodules (some green) due to the parasite *Strongylus rufescens*. (Badly termed "pseudo-tuberculosis.")
3. Cross-section of fatty liver (bovine).
4. Portion of surface of bovine liver, showing a single cyst, probably hydatid.



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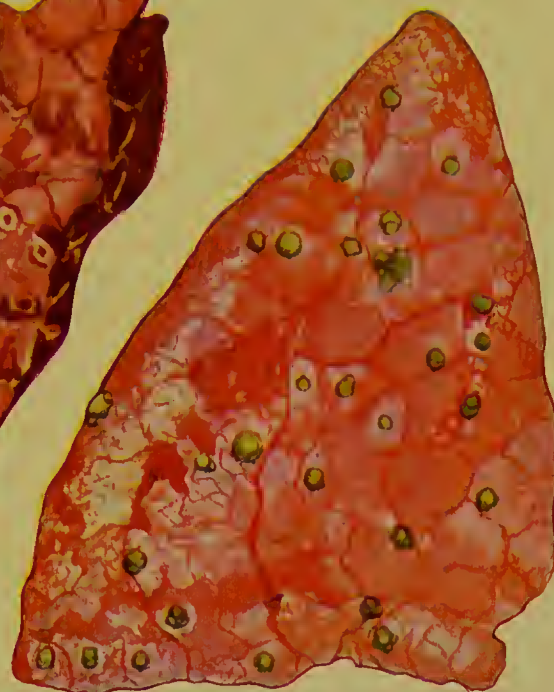

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to sheep. Where it is not practicable, perhaps, to erect pumps and troughs, a good plan is to cast lime all round the edges of the dams, from which stock are watered, so that the water just laps it. Water takes up in solution a certain amount of lime and no more, and, since the water that the stock ingests near the edges contains lime in solution, it is sure to be parasiticidal to fluke-embryos. The lime requires to be occasionally renewed around the edges of the dam.

"During spring and early summer there would be a minimum of risk in grazing sheep on unsound country, for then the fluke-embryos are undergoing various stages of development in the bodies of snails. If sheep are grazed over such country in the late summer and autumn they would undoubtedly contract fluke.

"On high lands, and on country that is well drained, and on the salt-bush plains of the Riverina, fluke does not prevail. In very dry seasons flukes are never troublesome, so dryness of pasture-lands is an essential condition in the prevention of fluke. It is practically impossible to treat large tracts of country with salt, except at enormous outlay; but, when holdings become less extensive, and more attention is bestowed on the cultivation of grasses, liming land will then be found not only practicable but profitable."

Preventives to Fluke Invasion. "As preventives to fluke invasion, and also as remedies when actually invaded, licks of sulphate of iron 50 lb., common salt 560 lb., and ground ginger 10 lb., should be distributed over the pastures. Sheep will voluntarily partake of iron and salt, but if they should not do so readily, sprinkle a little fodder over the licks, and then they will. Rock-salt blocks should also be distributed over the pastures, as sheep readily and voluntarily lick them.

"Iron and salt are tonics to sheep. They further act in such a way that they may kill the fluke-embryos in the stomachs of sheep on being introduced there; or they may so improve the general health as to make the system, in a measure, resistant to flukes. The licks require to be so covered over that rain cannot damage them, and yet be accessible to the sheep. Common salt and sulphate of iron are soluble in water, so if left unprotected from the weather they would be washed away with the rains. The strength of the sheep during the vermicious attack must be sustained by good feeding, so that the invaded animal may be able to withstand the extra strain on its system."

In the foregoing account the months given are for the Australian year and seasons, which are, of course, reversed in Great Britain.

CHAPTER XI

COMPARATIVE ANATOMY OF MEAT ORGANS

It is absolutely necessary that the modern meat inspector should have an accurate knowledge of certain parts of the science of comparative anatomy, since, as an expert in the subject, he is expected to be able to differentiate between the various organs of cattle, sheep, and pigs, and to readily distinguish between these and the same organs from other animals, such as the horse, which may be substituted for them for sale as food. It is no part of our task to give a detailed account of all the anatomy of the meat animals, and what is required in that direction is amply provided in the models and diagrams in these volumes. For any further detailed information concerning the intimate anatomical structure of the meat animals, readers are referred to various standard text-books on comparative anatomy. All that is necessary, therefore, for us is to group together in a form convenient for reference those important facts and descriptions which will enable the inspector to distinguish between the liver, lungs, kidney, and so forth of the different species of animals. The information necessary in order to detect the age and sex of others has already been given.

Deceptive Colours of Lungs. One of the very first things that the young meat inspector will be struck with is the immense variation in the colours and general appearance of lungs which cannot be demonstrated to be otherwise than normal anatomically. This is especially the case in the lungs of pigs, though the same thing applies to bovine lungs also. If the observer will cause a dozen pairs of lungs in the pig slaughterhouse to be hung up in a row in a good light he will notice that hardly any two of them exhibit the same colouring. There will be every variation from extremely pale anæmic-looking organs to somewhat darkly congested ones with here and there specimens showing small mottled areas alternately light and dark.

The cause of this great variation in colouring, in specimens which are not morbidly altered, is to be found in the degree of perfection of bleeding to which the pig carcase has been subjected. This differs immensely in the lungs, according to the precise manner in which the knife has been applied, as in many cases there is a sudden regurgitation of blood to the lungs, which do not thereafter empty themselves properly, giving an artificial appearance of congestion. In other cases the pig may have had a slight cold or bronchial catarrh at the time of death, and this or some other trifling ailment may be sufficient to prevent a thorough emptying of the lungs when bleeding takes place. The mottled appearance indicates that some lobules are more empty of blood than others.

THE LUNGS

The Lungs in Swine. The trachea in pigs contains thirty-two cartilaginous rings and divides into two main branches, one for each lung. A special branch enters the front part of the right lung. The lungs are

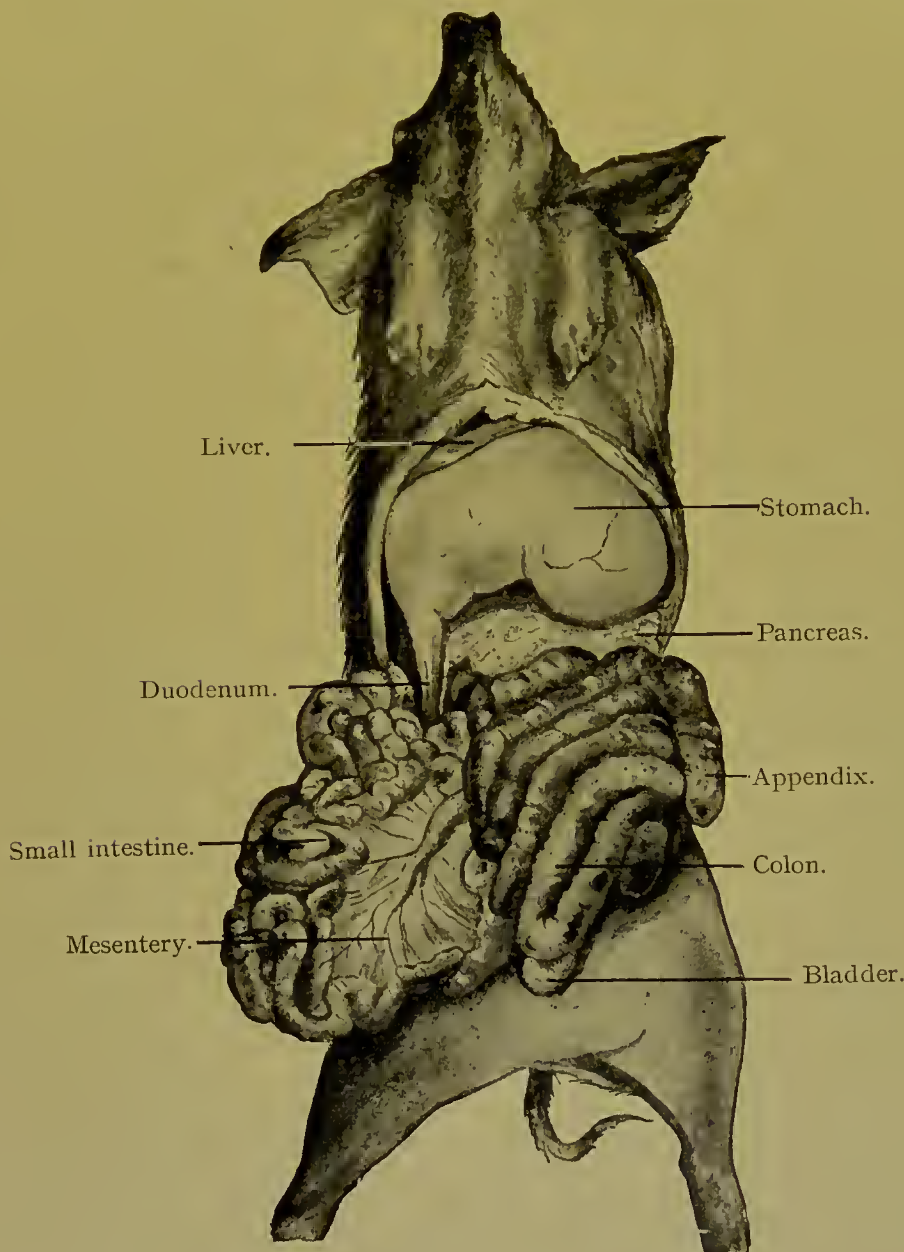


FIG. 1.—INTERNAL ORGANS OF THE PIG

divided into three or four lobes on the right side, and into two or three on the left. The pleura is attached partly to the ribs and partly to the diaphragm. The lungs are soft and elastic, varying immensely in actual colour in normal specimens, according to the perfection of bleeding which has taken place when the animal was slaughtered. Pale to bright pink are the most common colours. The interlobular tissue is not so well developed as it is in the ruminants. The surface should be smooth and glistening.

The Lungs in Horses. The equine lungs have a left, anterior, and posterior primary lobe, besides a pyramidal lobe to the right (Ostertag).

The Lungs in Cattle. The bovine trachea has about fifty cartilaginous rings and ends in three large bronchi. The lungs are right and left, together with a middle lobe sometimes regarded as a division of the right lung. The right lung is divided into three or four lobes, including the middle one ; the left lung into two or three. The interlobular connective tissue is well marked and often emphysematous.

The Lungs in Sheep. The trachea has from forty-eight to fifty-five rings, and divides into three main branches. The right lung is divided

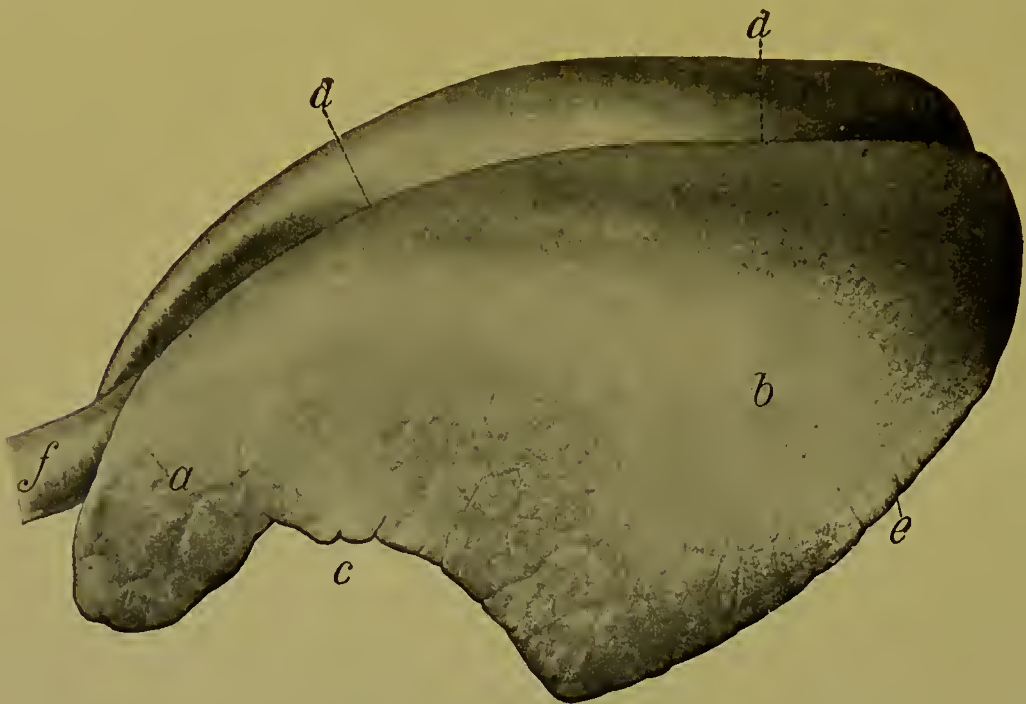


FIG. 2.—LUNGS OF HORSE. (ELLENBERGER AND BAUM.)

a. Pointed lobe.
b. Body of lung.
c. Cardiac groove.
d. Dorsal border (blunt).
e. Ventro-lateral border (sharper).
f. Trachea.

into four or five lobes, and the left into two or three. The colour is usually pale yellowish red, frequently mottled with small spots due to the presence of worms.

All ruminant lungs exhibit a number of lobes ; two or three on the left and four or five on the right, while the anterior lobe in the right lung of ruminants receives a bronchus directly from the lower end of the trachea. The lungs of cattle exhibit well-marked interlobular tissue which is frequently distended with air, the whole lung being rose-red in colour and showing a smooth glistening surface.

THE LIVER

Comparative Anatomy of the Liver. In all domesticated animals which come under our notice there is considerable difference in the shape, size, and anatomical position of the liver, differences which enable that

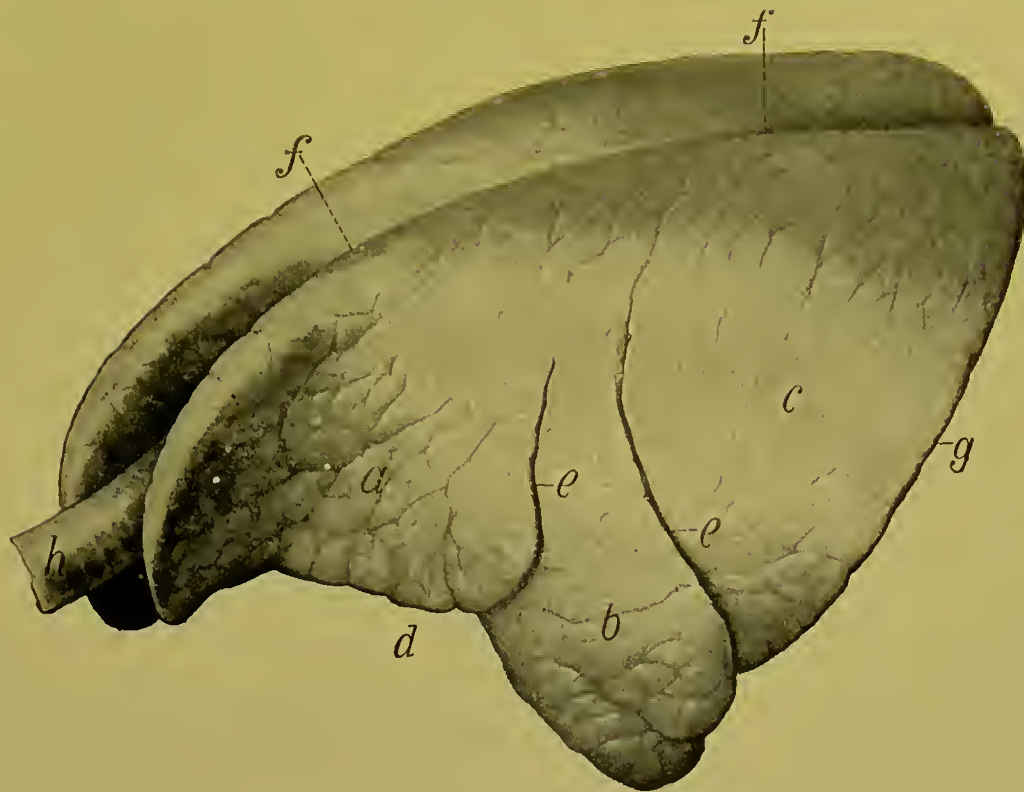


FIG. 3.—BOVINE LUNGS. (ELLENBERGER AND BAUM.)

a. Apex. *b.* Cardiac lobe.
c. Diaphragmatic lobe. *d.* Cardiac groove.
e. Interlobular septa. *f.* Dorsal thick border.
g. Ventro-lateral sharp border. *h.* Trachea.

organ to be recognised readily in the various species. At the same time the histology does not differ in essential particulars except in the arrangement of its connective-tissue framework. As far as the horse is concerned the outstanding feature of importance is the absence of the gall-bladder, and the average weight of a healthy liver in that animal in medium-sized horses is about 11 lb.

In the other animals which are possessed of a gall-bladder the principal biliary duct eventually dilates into a large receptacle for bile, which in fact forms the gall-bladder. This receptacle lies either partly or entirely on the posterior aspect of the liver and is either oval or pear-shaped,

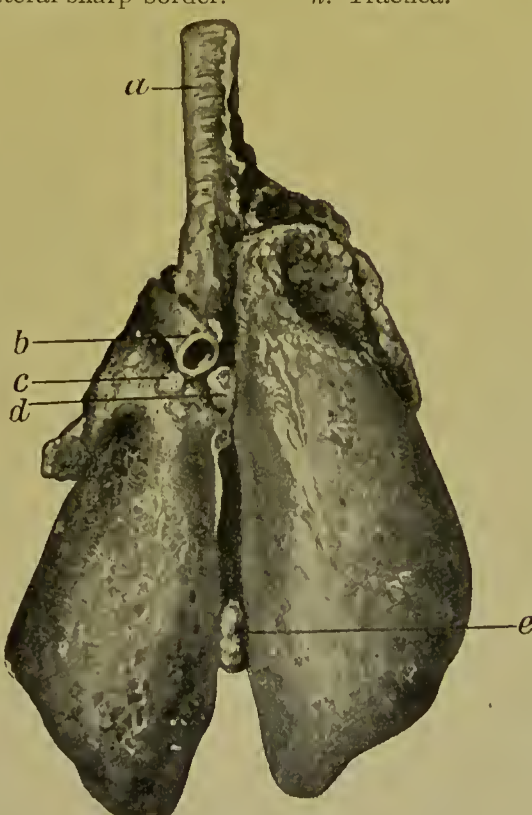


FIG. 4.—BOVINE LUNGS

a. Trachea. *b.* Aorta. *c, d, e.* Glands.

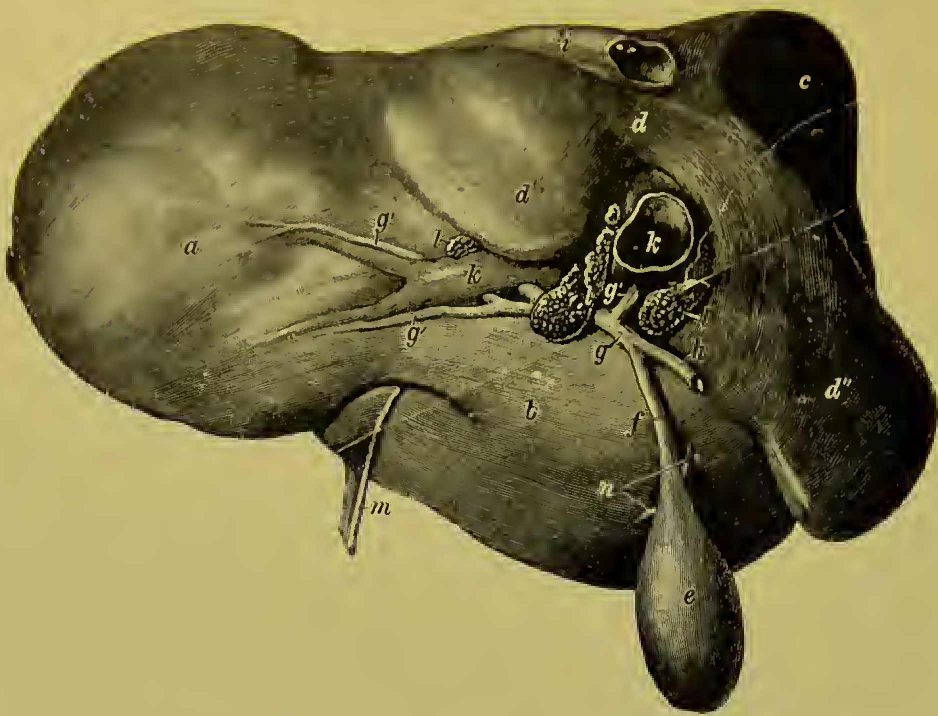


Fig. 5.—Visceral Surface of Bovine Liver. (Ellenberger and Baum.)

a. Left lobe.
b. Middle (quadrate) lobe.
c. Right lobe.
d. Caudate lobe.
e. Gall-bladder.
f. Cystic duct.
g. Hepatic duct.
h. Ductus choledochus.
i. V. cava caud.
k. Portal vein.
l. Portal gland.
m. Lig. teres.
n. Hepatocystic ducts.

having a peritoneal covering externally, and beneath this coats of fibrous mucous tissue. The secretion of bile by the liver is a continuous process, but its discharge into the intestines is interrupted between the intervals of

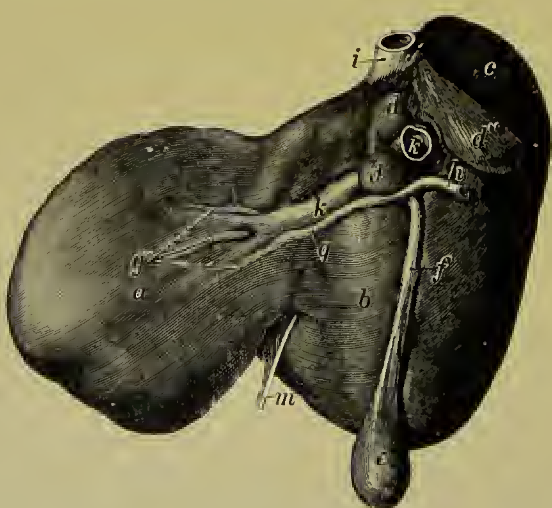


Fig. 6.—Liver of Sheep, seen from Visceral Surface. (Ellenberger and Baum.)

a. Left lobe.
b. Quadrate lobe.
c. Right lobe.
d. Caudate lobe.
e. Gall-bladder.
f. Cystic duct.
g. Hepatic duct.
h. Ductus choledochus.
i. V. cava caud.
k. Portal vein.
m. Lig. teres.

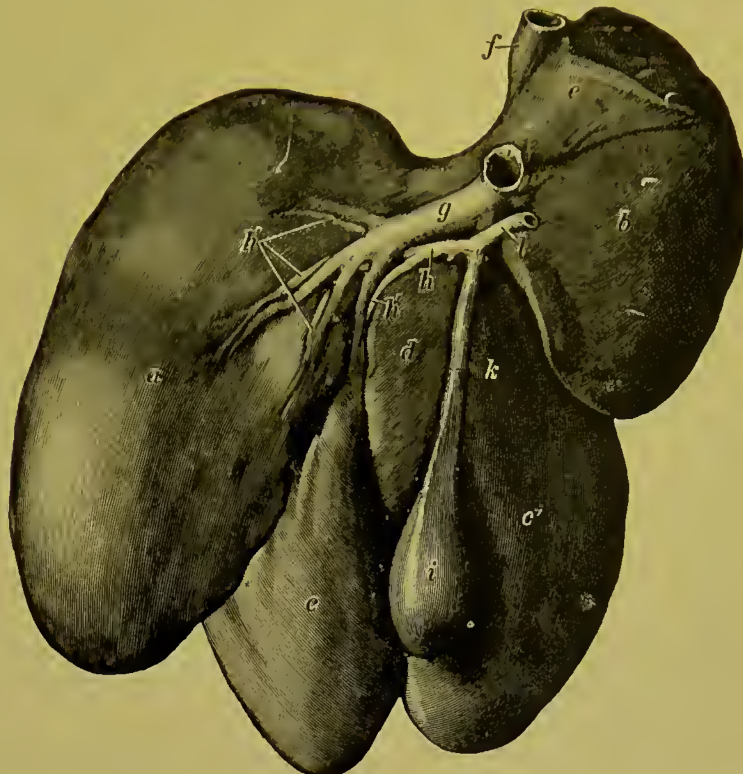


FIG. 7.—LIVER OF PIG, VISCERAL SURFACE. (ELLENBERGER AND BAUM.)

a. Left lobe.
b. Right lobe.
c, c'. Middle lobes.
d. Quadrate lobe.
e. Caudate lobe.
f. V. cava caud.
g. Portal vein.
h. Hepatic duct.
i. Gall-bladder.
k. Cystic duct.
l. Ductus choledochus.

digestion, accumulating in the gall-bladder. When digestion begins the accumulated bile is driven by muscular contraction and pressure into the duodenum.

FIG. 8.—BOVINE LIVER

a. Portal gland. *b.* Vein. *c.* Bile-ducts. *d.* Gall-bladder.

The Bovine Liver. The liver in the ox is a large thick organ which lies in the right diaphragmatic region. The notches which are present at the margin in the liver of some animals are in this case hardly obvious and for this reason the division of the organ into separate lobes is a very imperfect one. The ox liver is rather one large solid mass. The gall-

FIG. 9.—COMPARISON OF SPLEENS OF HORSE, OX, PIG, SHEEP, DOG

a. Line of transverse sections; appearance of spleens on section seen in the four illustrations at bottom. (Ellenberger and Baum.)

bladder is attached towards the superior extremity, receiving near its neck the large ducts coming from the upper portion of the organ.

The Liver in Sheep. In the sheep, except for the great difference in total size of the organ, the anatomical configuration is very similar to that of the ox. It may be noted, however, that the ductus choledochus unites with that of the pancreas.

The Liver of Swine. In the pig the notches at the periphery are deep indentations dividing up the organ into three or four very well-marked lobes, to the middle one of which the gall-bladder is attached. (*N.B.*—In dogs and cats the liver is very large in comparison with the size of the animal, and being deeply notched is divided into at least five main lobes,

the middle one of which lodges the gall-bladder in a depression.) The anterior surface is convex, the posterior concave. The colour is dark reddish or brown. The single portal lobules can be readily seen with the naked eye, this feature serving to distinguish the pig's liver from that of the other meat animals.

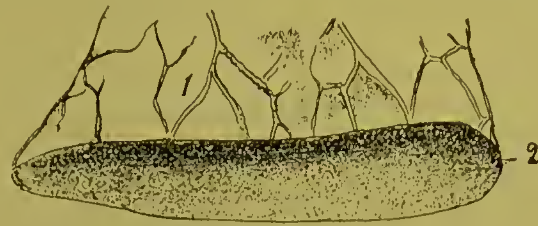


FIG. 10.—SPLEEN OF PIG
1. Omentum. 2. Spleen.

General Points of Liver. In swine the liver has four lobes as well as a gall-bladder, and the substance of the organ is readily recognised by the large amount of connective tissue which it contains as well as by the large size of each lobule, these being quite readily distinguished, owing to the connective tissue running between them. Both this and the bovine may readily be distinguished from that of the horse, which has three lobes, the right lobe being the largest, the middle lobe the smallest, and by the absence in this animal of a gall-bladder. All normal livers should show a glistening appearance on section with a moderately firm consistence, and there should be no blood in the large veins when cut across. The colour is purplish, becoming the more inclined to red after being exposed for some time. Livers which are yellowish in colour, soft in consistence, and having thick rounded borders, point to the condition of fatty infiltration.

The liver in the ox is practically of two lobes with a pear-shaped gall-bladder attached. The average weight of this organ being about one-fifty-second part of the total dressed weight of the carcase.

FIG. 11.—SPLEENS
a. Bovine. *b.* Sheep. *c.* Pig.

The Spleen. This organ varies very markedly in shape in the different animals, attaining its greatest volume some four or five hours after feeding. In the ox its shape is that of a long oval body flatly compressed with rounded edges, being of a reddish brown colour, firm and thick, with convex surfaces in bulls and fattened steers. In the cow, however, the consistence is more flabby, the surface more flat, and the colour more greyish. The borders are rounded most in bulls and steers and most sharp in cows. In young calves the spleen is the

same colour in both sexes, softer in consistence with fairly rounded borders, and moderately convex surfaces. In sheep the spleen is somewhat of the same shape as that of cattle, but of course very much smaller, while in swine its shape is more that of the tongue and the consistence is flabby. All these three differ markedly from the spleen of the horse, which is flat and sickle-shaped. These varying shapes, as well as the proportionate sizes in reference to each other, can be best realised from the illustration appended.

Comparative Anatomy of the Spleen. This gland, which differs from most others in having no excretory duct, as well as in its histology, varies

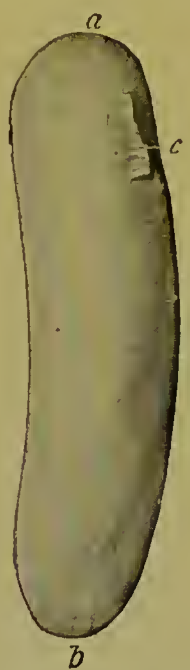


FIG. 12.—BOVINE SPLEEN, VISCERAL SURFACE

a. Dorsal end. *b.* Ventral end. *c.* Hilus.

(Ellenberger and Baum.)

FIG. 14.—SPLEEN OF SHEEP, VISCERAL SURFACE

a. Dorsal end. *b.* Ventral end. *c.* Hilus.

(Ellenberger and Baum.)

FIG. 13.—SPLEEN OF PIG, VISCERAL SURFACE

a. Dorsal end. *b.* Ventral end. *c.* Hilus.

(Ellenberger and Baum.)

considerably in shape and form in the different animals and there should be no difficulty in determining the origin of any particular specimen of the organ in the ruminants. The spleen is found attached to the left side of the rumen and to the diaphragm and is not supported, as it is in some other animals, by the great omentum. If one examines the spleen in cattle it will be observed that the organ is elongated in shape, rounded at both ends, practically of equal widths throughout its entire length, and also of equal thickness.

In the pig the same description applies, the main differences being in the actual size of the organ, which is smaller in every dimension and perhaps somewhat thinner in proportion.

The spleen in the sheep, however, is of an entirely different shape, being roughly triangular, having rounded edges and being thickest in the central portion.

These various differences in gross anatomical structure are all readily recognised in our respective illustrations.

Comparative Anatomy of the Pancreas. This organ in the bovine animals occupies a position between the layers of the mesentery, unlike the position in the horse, where it is situated in the sublumbar region. In the ox it is just to the right of the great mesenteric artery. There is one duct which opens in the small intestine from 14 to 16 in. below that from the gall-bladder.

The pancreas in sheep and also in goats has the same anatomical arrangement as that seen in the ox except that the ducts open into the intestine along with those from the liver.

In the pig the pancreas is situated partly in the sublumbar region and partly in the duodenal frænum. It opens from 4 to 6 in. behind that of the gall-bladder. (*N.B.*—In dogs and cats the pancreas is an elongated organ situated between the mesenteric layers.)

KIDNEY

Comparative Anatomy of the Kidneys. This valuable portion of the carcase, which is everywhere used for food, differs very considerably in shape and form in some animals, whilst in others it is very similar. But since the consumer or purchaser generally requires from the meat-purveyor certain special kidneys, it is the duty of the latter to sell only that description of kidney which is asked for. Thus, since it is illegal in this country to sell horse-flesh of any kind for human food except under definite declaration, it is necessary that the inspector should be able to recognise the kidney of other animals from those of horses, just as in the case of other organs.

The Kidney in the Horse. The external appearance in this animal is different on the two sides, and in both kidneys different from that of the other meat animals. The horse's kidney on the right side is often compared in shape to the heart in a pack of cards, a resemblance which is fairly accurate ; while the kidney on the left side is more aptly compared to the shape of a haricot bean. Both kidneys are flattened and perfectly smooth. On the inferior aspect there are a number of grooves, which receive arteries, while on the right kidney there is a special groove for the ureter. In each kidney the internal border is deeply notched to form the hilus, at which spot the vessels and nerves enter and emerge and the ureter originates. In an animal which varies so much in size as the horse it is of course obvious that the weight of the kidney will also vary immensely, but it may be noted that the right kidney in the horse is always larger and heavier than the left, the average weight being 27 oz., while the average weight of the left kidney in the horse is 25 oz. (Chauveau).

The Bovine Kidney. The primary distinction between mammalian kidneys as regards their external appearance is the presence or absence of lobulation, and it is in this respect that the kidney in the ox is at once

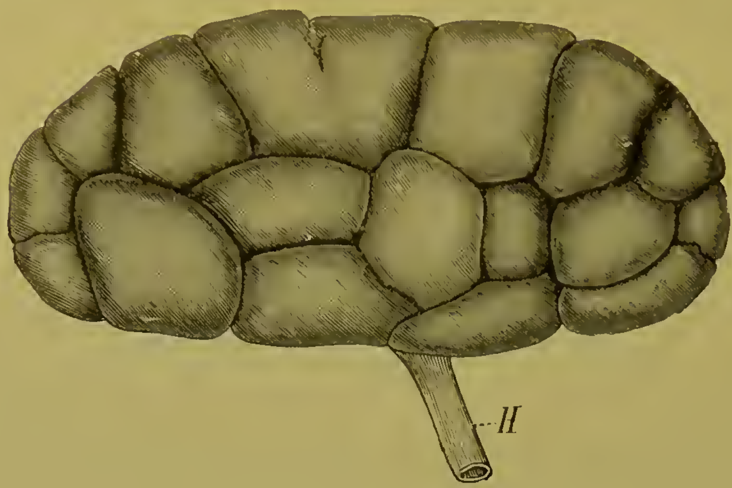


FIG. 15.—BOVINE KIDNEY, LOBULATED
H. Ureter. (Ellenberger and Baum.)

readily recognised from that of all the other meat animals. This simply means that in this animal the form of the kidney throughout life remains as it was in the fœtal stage, that is, the fœtal lobulation is persistent. It is important to remember that this lobulation is characteristic of a certain stage of the mammalian kidney, because it sometimes persists in other animals than the bovidæ. As far as we are concerned, however, it is only in that family that the appearance is normal after birth.

The kidneys in the ox are elongated in shape from before backwards, this shape in itself being a distinguishing character in relation to the same organs of horses, sheep, and pigs. Each kidney is seen to be made up of a number of distinct areas or lobules incompletely fused, the actual number of these varying from fifteen to twenty. The pelvis of the kidney is not found in the centre of these lobules, but is carried outwards, occupying the position on the interior aspect of the kidney known as the hilus.

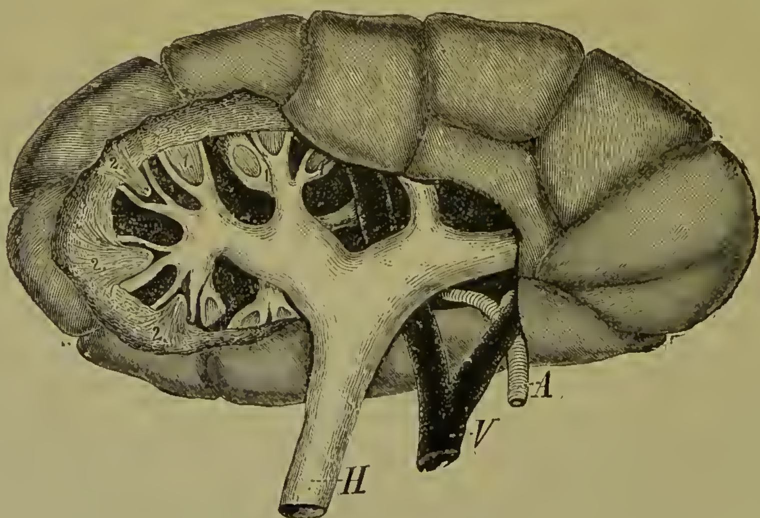


FIG. 16.—VENTRAL ASPECT OF BOVINE KIDNEY
(Part of kidney removed.)
A. Renal artery. *V*. Renal vein. *H*. Ureter. 1, 2. Renal papillæ and calices.
(Ellenberger and Baum.)

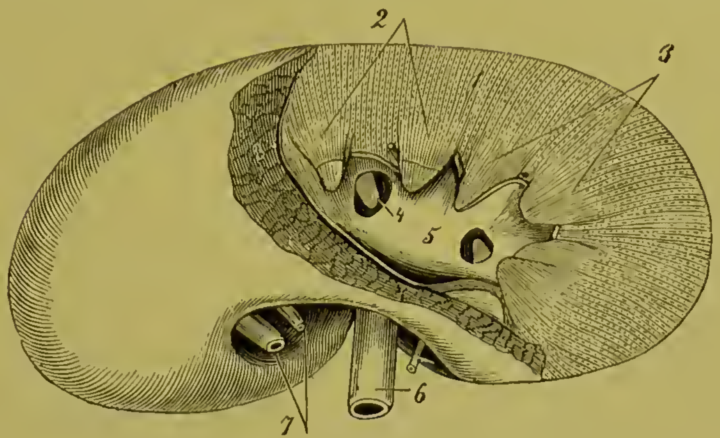


FIG. 17.—KIDNEY OF PIG
(Ellenberger and Baum.)
1. Cortex. 2, 3, 4. Renal papillæ. 5. Pelvis. 6. Ureter. 7. Hilus, blood-vessels.

The cavity of this pelvis is divided into a number of short and wide processes corresponding to the number of lobules present. These are the calices, and into the bottom of each calyx there projects the papilla, which is simply the crest of each lobule. These points can be readily seen in each illustration (Figs. 16 and 17).

The Kidneys of Sheep. In the sheep the kidneys are not lobulated externally, and their shape is quite different from that of the ox, being usually described as that of a kidney bean. The pelvis of the kidney has a large cavity and branches deeply into the substance of the organ. There is one renal papilla.

The Kidney of Pigs. In the pig this organ, like that of the sheep, is smooth and lobulated externally, and rather more voluminous than in the sheep. In the cavity of the pelvis there are six to eleven papillæ

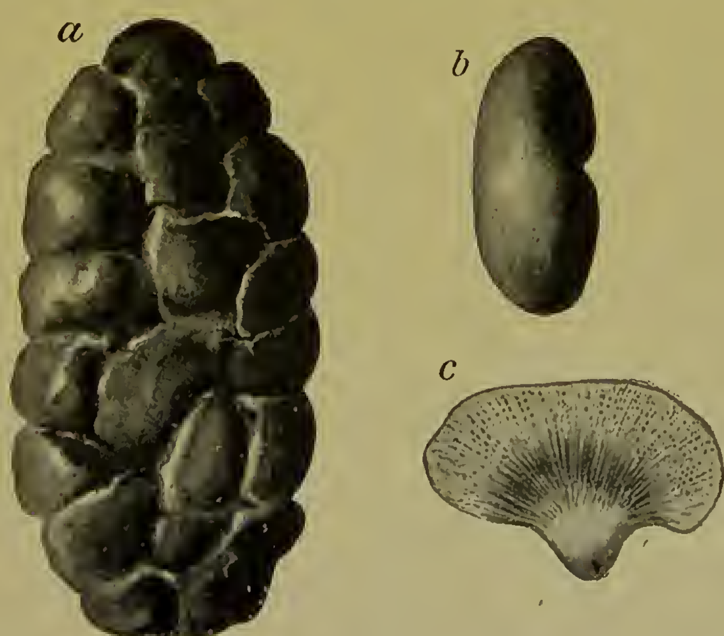


FIG. 18.—KIDNEYS
a. Bovine. *b*. Pig. *c*. Section of a single lobule of bovine kidney.

grouped in twos or threes corresponding to the number of calices (Fig. 18).

General Points of Kidneys. In most animals which are slaughtered the kidneys cannot be seen until they have been removed from the fat which surrounds them, which is probably one of the reasons why they frequently escape inspection. In all animals the colour is much the same, that of a reddish brown tint, the consistency being firm, the surface smooth and glistening. In cattle both kidneys are oval in shape and are lobulated, each containing from fifteen to twenty lobules, of varying sizes. Each of these lobules has its own papilla. In sheep the kidneys are the shape of beans, there being no lobules and one single papilla. In swine the kidneys are the same shape as in sheep, namely, bean-shaped, and similarly they are not lobulated. They differ, however, from those of sheep by having from six to eleven papillæ. As before mentioned, in the horse the right kidney is the shape of a heart, while the left is the shape of a bean.

The Heart. This organ is practically of the same character in all domestic animals, being of a firm consistence, containing very little blood in its muscle, having a smooth covering and a smooth lining. In the beef animals there are two bones found in the aorta, while in old sheep a small bone is found in the right side of the heart.

Comparative Anatomy of the Heart. The heart is usually sold as part of the pluck along with the lungs, but in the retail trade it is sold separately, and the inspector must therefore be able to recognise the

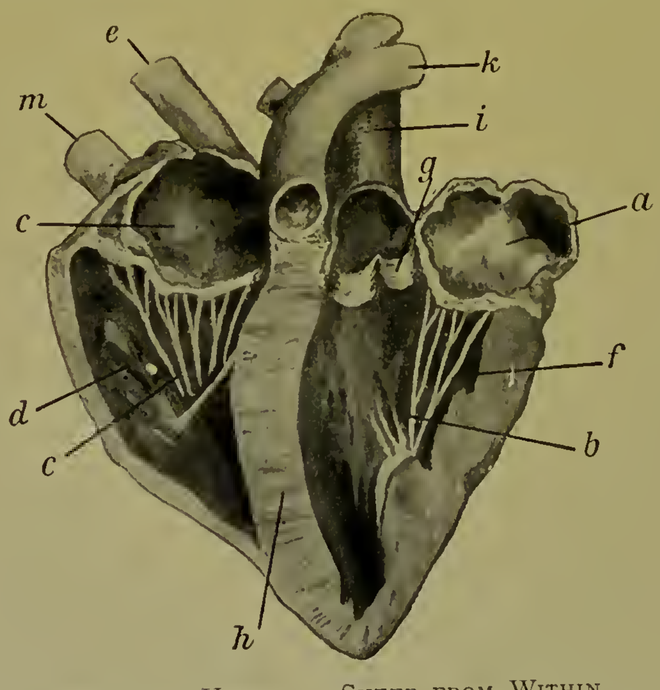


FIG. 19.—HEART OF SHEEP FROM WITHIN

a. Left auricle.
c. Right auricle and valve.
e. Anterior vena cava.
g. Semi-lunar valve.
i. Aorta.
m. Posterior vena cava.
b. Left ventricle.
d. Right ventricle.
f. Mitral valve.
h. Septum.
k. Pulmonary artery.

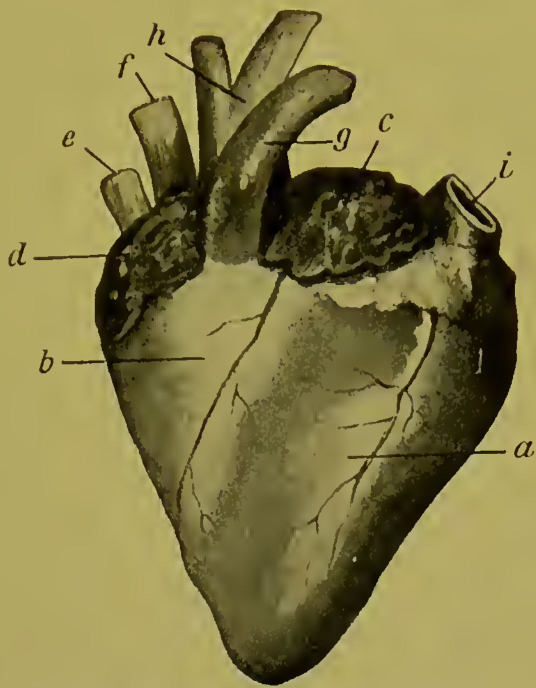


FIG. 20.—EXTERIOR OF HEART OF SHEEP

a. Left ventricle.
b. Right ventricle.
c. Left auricle.
d. Right auricle.
e. Posterior vena cava.
f. Anterior vena cave.
g. Pulmonary artery.
h. Aorta.
i. Pulmonary vein.

hearts of the different animals. In cattle and sheep the shape of the ventricle is more conical than it is in the horse, and in those animals there are three grooves, one of which passes behind the left ventricle. In the ox there are two cardiac bones, the largest being on the right side where the aortic origin joins the opening into the ventricle. The bone is triangular in shape with the base pointing upwards and about 2 in. long. The second of these bones is not always present. The average weight of the heart in the ox is about 3½ to 4½ lb. In the sheep the average weight is from 5½ to 7 oz., and in this animal, too, there is a bone in the organ. In pigs the heart is more the shape of the organ in the horse, being less conical than in cattle and sheep.

THE UTERUS

Comparative Anatomy of the Uterus. "With regard to form, the uterus of the cow presents a very remarkable disposition, which it is necessary to note. The concave curvature of the cornua looks downwards, while in the mare it looks upwards ; though in both the sublumbar ligaments are attached to this concavity. Therefore it is that in the cow—if we consider the uterus as freely suspended in the abdomen —the extremity of the cornua is twisted outwards and upwards, while the base, although drawn in the same direction by these ligaments, maintains its direction, because it is in a manner fixed by the body of the uterus. The latter receives, like the cornua, the insertion of the broad ligaments on its lower plane, so that it overlaps them, while the uterus

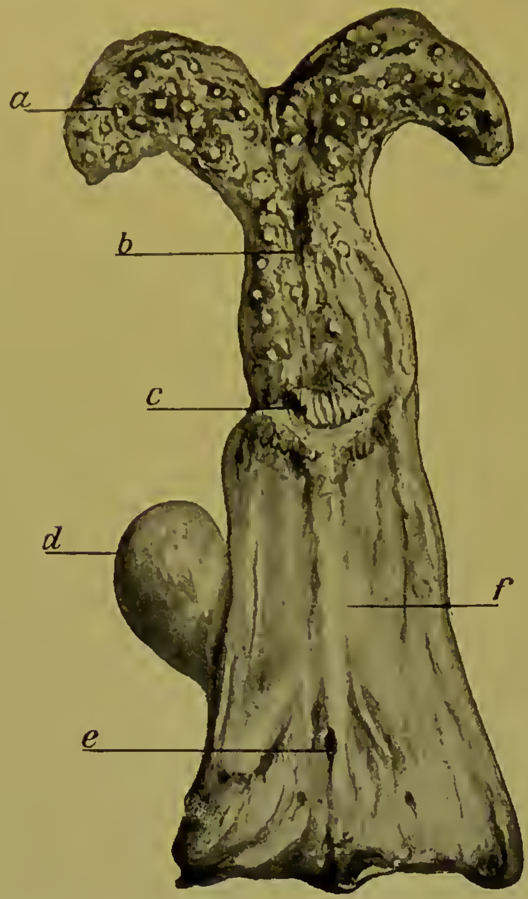


FIG. 21.—VAGINA AND UTERUS OF COW

a. Cornu. *b*. Body. *c*. Cervix. *d*. Bladder. *e*. Urethral orifice. *f*. Vagina.

of the mare projects below them. Otherwise, these ligaments are very ample, especially at their anterior border; they are wide apart in front towards their lumbar attachment, which is prolonged even on the parietes

FIG. 22.—UTERUS OF SOW

1. Ovary. 2. Oviduct. 3. Cornu. 4. Broad ligament. 5. Body of uterus. 6. Neck. 7. Urethral orifice. 8, 9. Vagina.

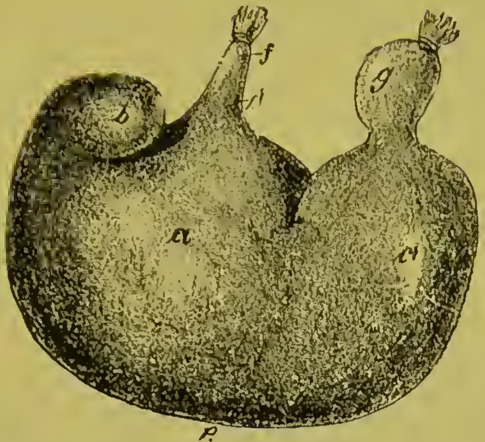


FIG. 23.—STOMACH OF PIG

a. Left half. *b*. Pouch. *c*. Right half. *d*. Lesser curvature. *e*. Greater curvature. *f*. Gullet. *g*. Commencement of small intestine.

FIG. 24.—LARGE INTESTINE OF PIG

of the flank. The ligaments may be altogether compared to a triangular cravat, one angle of which is attached to the bottom of the pelvic cavity, and the other two to the tuberosities of the ilium. On this cravat lies the body and part of the cornua of the uterus.

"The uterine cornua are thin and tapering at their anterior extremity. The body is short and narrow. The interior of the uterus is less ample than that of the mare. Its surface is studded with rounded tubercles, known as *cotyledons*. They are numerous in the cornua, but small and few in the body of the organ" (Chauveau).

Uterus in Sheep. In sheep the general arrangement is very similar to that in the cow, except that the cotyledons are more truly cup-shaped and hollowed out, and the cornua are longer and more pendant.

The most important organs which have to be distinguished from each other as far as source and origin is concerned are the spleen, liver, lungs, and kidneys, each of which presents specific peculiarities according to the animal from which it comes, as we have seen. Other parts of the internal organs, however, are used in various ways in connection with the preparation of food: for example, the stomach and intestines, and of course the tongue.

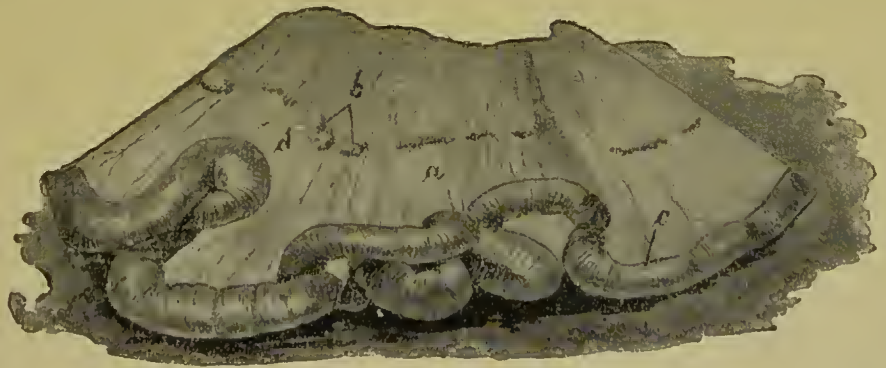


FIG. 25.—SMALL INTESTINE OF PIG

a. Mesentery. *b*. Mesenteric glands. *c*, *d*. Intestine.

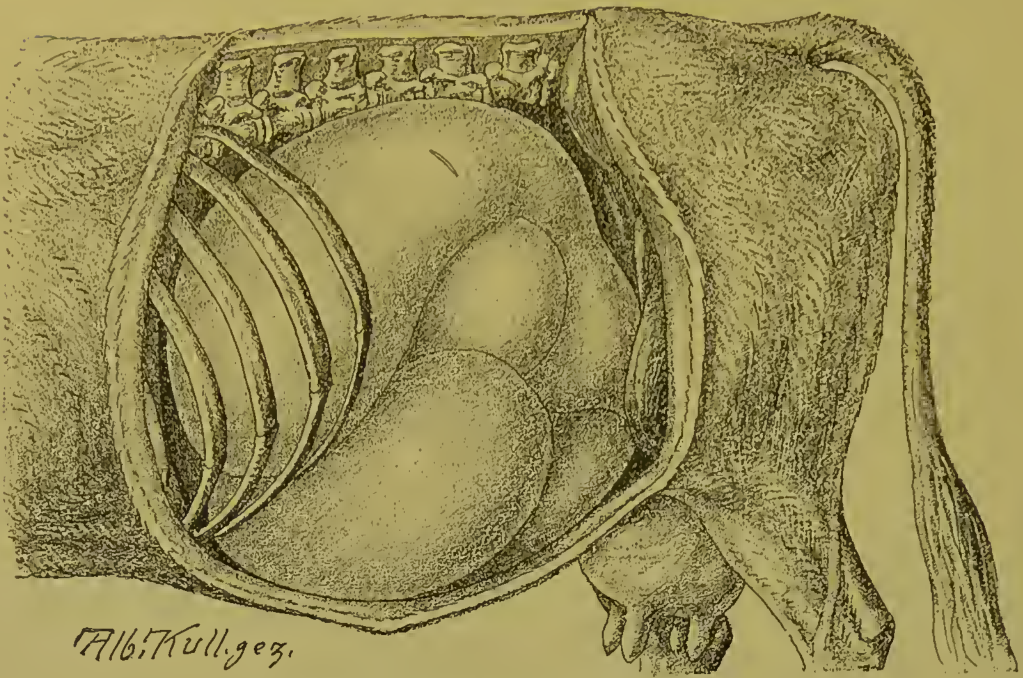


Fig. 26.—Bovine Stomach, "in situ"

The Stomach. As far as the alimentary tract is concerned, it is principally used in the meat industry to form the casing for sausages. The stomach itself is used partly for food in the shape of tripe, and partly for sausage casing. The famous Scottish dish of "haggis" is also made from various organs of the body which, after being minced and

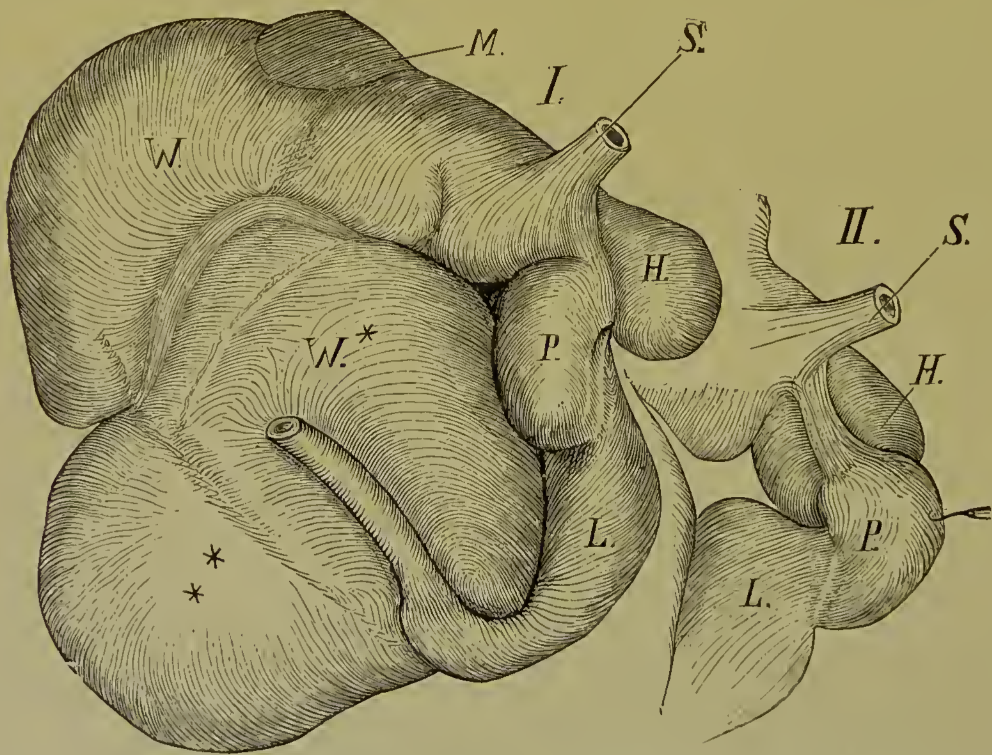


Fig. 27.—Stomach of Sheep. (Ellenberger and Baum)

I. The compartments of the stomach in natural position. *H.* Head. *L.* Reed. *M.* Spleen. *P.* Manyplies. *S.* Œsophagus. *W.** Paunch, rumen, ventral. *W.* Rumen, dorsal.

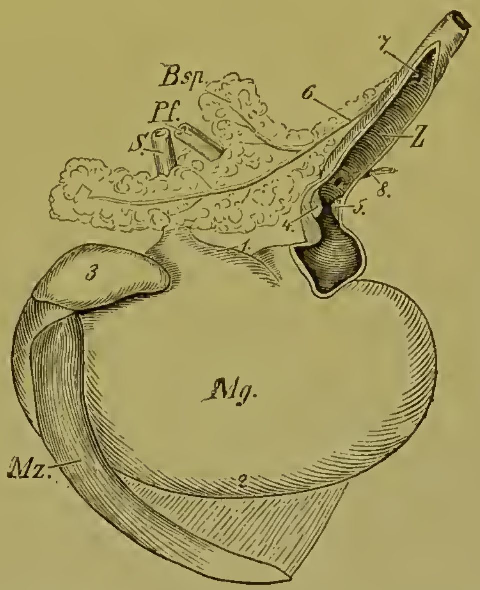
II. The manyplies is drawn on one side from the rumen, to show the relations.

suitably flavoured, are cooked in a sheep's stomach. Various commercial products are also derived from the stomach; pepsin being obtained from that of swine, and rennet from the stomach of calves; while the serous coat of the intestines is used both to prepare plasters and also for the basis of gold-beaters' skin.

The meat inspector will never learn to distinguish the organs of various animals from mere verbal descriptions; nothing but actual seeing and handling is of much real use. It is, therefore, unnecessary to give full anatomical descriptions of stomachs, lungs, livers, and spleens in a work of this sort. We are of opinion that our purpose will be far better served by giving a series of illustrations of these organs which can readily be applied to the carcase and its parts. Many of these are taken from the best continental sources, and we would thank, in particular, Professors Ellenberger and Baum for their very kind

FIG. 28.—STOMACH, GLANDS, AND SPLEEN OF PIG (Ellenberger and Baum.)

Bsp. Pancreas.
Mg. Stomach.
Mz. Spleen.
Pf. Portal vein.
S. Œsophagus.
Z. Duodenum.
1. Small curvature.
2. Large ,,
3. Diverticulum.
4., 5. Pyloric muscles.
6. Pancreatic duct.
7. Duodenal contents.
8. Bile-duct.



permission to use a large number of the excellent illustrations from their great work, "Anatomie der Haustiere" (August Hirschwald, Berlin, 1908).

We have already described and illustrated the bovine stomach (Vol. I. p. 8), and the following illustrations will exemplify the stomachs of the sheep and pig, namely, Figs. 27 and 28.

The Tongue. This organ, which is extensively used for food in both the fresh and the preserved state, shows certain differences in different animals in shape and detailed anatomy. The tongue of cattle has a slender tip, a strong dorsal ridge frequently showing black spots on its surface, and possessing a large number (twelve at least) on each side of circumvallate papillæ. In sheep the tongue exhibits a hollow at the tip in the middle line; the whole organ may be black, this frequently corresponding to the colour of the sheep itself. In swine there is no dorsal ridge, and there are only two circumvallate papillæ on either side.

THE MAMMARY GLAND

Comparative Anatomy of Mammary Gland. The udder in the cow is really composed of two lateral halves, each of which again is divided

Fig. 29.—Bovine Tongue, partly from the Side
(Ellenberger and Baum.)

1. Point of tongue with filiform papillæ.
2. Body of tongue. 3. Root ,,
a. Tonsil. *b.* Back of tongue.
c. Pharynopalatine arch.
d. Circumvallate papillæ.
e. Ridge of tongue, numerous papillæ.
f. Fungiform papillæ.
g. Side. *h.* Epiglottis.
i. Plica glosso-epiglottica mediana.

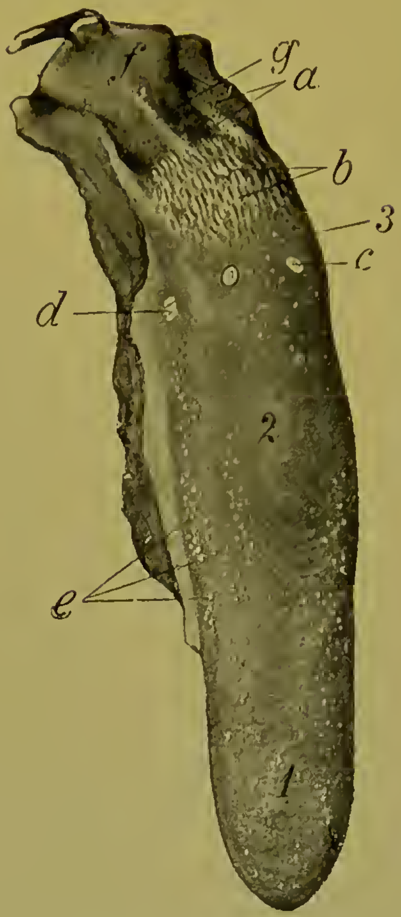


Fig. 30.—Tongue of Pig
(Ellenberger and Baum.)

a. Tonsil.
b. Back of tongue
c. } Circumvallate papillæ.
d. }
e. Fungiform papillæ.
f. Epiglottis.
g. Glosso-epiglottic fold.
1. Tip of tongue.
2. Body of tongue.
3. Root of tongue.

into two ; so that the whole organ consists of four mammæ, each with its respective teat. Additional teats may be present, but if so are small and rudimentary. The size of the udder varies much in different breeds of cattle, and may extend from the pubis to the navel. From the fact that each quarter of the whole gland is anatomically distinct from the others, it happens that certain morbid conditions may be found to affect one quarter only.

In sheep the udder is a large compound gland divided into two halves, each half having two teats which are hairy.

In the sow the udder reaches from the pubis to the sternum, and consists of no fewer than from eight to ten mammary glands on each side, each with its corresponding teat. The teats are bare. These various arrangements are seen in the illustration (Fig. 2, p. 966).

CHAPTER XII

THE LYMPHATIC GLANDS

So much importance is, of necessity, attached to the condition of the various lymphatic glands in the body, and so much attention has to be paid to these in the course of any adequate inspection, that it is absolutely necessary for the meat inspector to possess a thoroughly accurate knowledge not merely of the precise anatomical situations in which the various groups of glands are to be found, but also the exact communications of the vessels which carry lymph from and to these glands, and thus drain the parts of the body in which they are in communication. A gland which has definite communications with a distinct anatomical area is termed the "corresponding" gland of that area. Furthermore, it is a necessity that the meat inspector should be perfectly familiar with the normal appearance of glands in various animals, an appearance which varies somewhat with age and species, especially in the directions of size and colour as well as of actual consistence. Even the shape is by no means constant, though the majority of lymphatic glands are found to be round or oval. Some are not larger than an ordinary pea, while others are the size of a cherry or even that of a walnut. It is a general rule that lymphatic glands in animals, which are still in the stage of growth and development, are larger than glands in aged animals, glandular tissue being one of those which readily undergoes senile atrophy. Where the glands lie in a bunch or group they are frequently pressed closely together. The colour varies from almost pure white (which predominates in pigs) to a mottling of partly white and grey and blue. Glands are extremely sensitive to conditions of blood and lymph pressure, conditions which very readily alter their consistence and their size. Normally, that consistence should be somewhat firm and not actually soft, but the actual size of the gland depends to a very considerable extent upon the amount of fluid contained. All lymphatic glands become very readily swollen under the action of any local or general irritant, a phenomenon which is readily observed in the case of all forms of blood poisoning in which the glands nearest to the side of infection quickly swell up. If an incision be made across the lymphatic glands a certain amount of fluid escapes, the quantity of which often determines the softness or hardness of the gland in question. Thus all the glands in the thorax are firmer in consistence than those of the abdomen.

The Lymphatic Stream. The distribution of lymph in relationship to the lymphatics is a perfectly definite one, coming from a particular region for which the lymph gland is the corresponding one. In some

situations a number of glands correspond to a certain area. The lymphatic vessels, which pour their contents into the gland, also have a very intimate ramification in the organs and tissues which they drain, and there is a very intimate system of anastomosis between all lymphatic vessels in the same area of the body. It is this fact which, as a rule, prevents any absolute stoppage of the lymph circulation in a part. Ultimately the lymph from the lymphatics is collected and emptied into the main lymphatic trunk or the thoracic duct, but none of the lymph so emptied reaches the thoracic duct until it has been passed through at least one gland or group of glands. Despite the very intimate anastomosis of the lymphatic circulation there is, however, no lymphatic connection necessarily existing between the lymphatic vessels of two or more organs which are anatomically distinct ; in fact, as a rule, no such connection exists. This explains many of the curious disturbances of lymphatic infection which come under our notice. The various lymphatic trunks which carry the lymph from their corresponding glands take it directly to the thoracic duct without transmitting it through any further organ. Thus Ostertag points out that there is no lymphatic connection between

FIG. 1.—BOVINE HEAD WITH SALIVARY GLANDS. (ELLENBERGER AND BAUM)

a. Parotid gland.
b. Submaxillary gland.
b′. ,, ,, throat end.
c. Ventral, *d*. Middle, *e*. Dorsal — cheek glands.
f. Lip glands.
g. Buccinator nerve.
h. ,, vein.

1. Masseter.
2. Lower jaw.
3. Zygomaticus.
4. Large lip papillæ.
5. Buccinator.

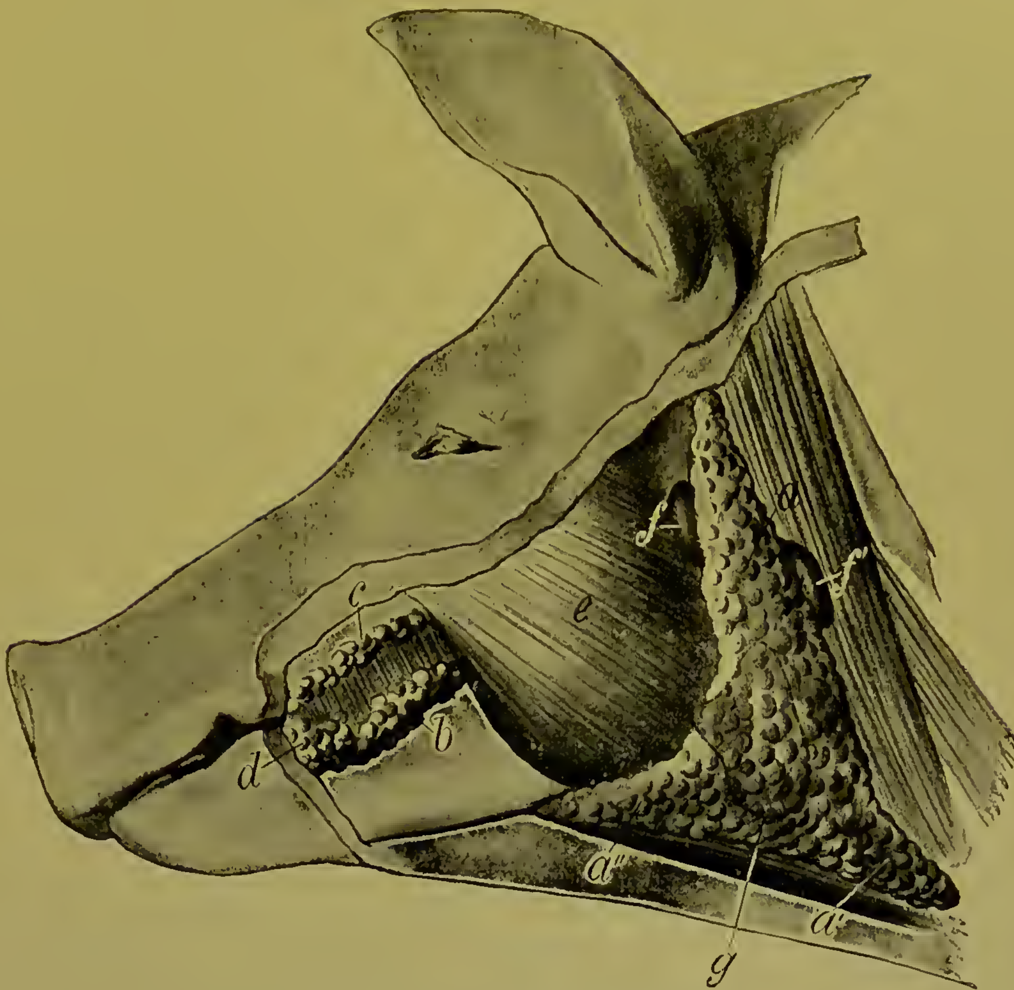


FIG. 2.—PIG'S HEAD WITH GLANDS
(Ellenberger and Baum.)

a, a′, a″. Parotid gland.
b. Dorsal cheek glands.
c. Ventral ,,
d. Lip glands.
e. Masseter.
f, f′. Lymph nodes.
g. The dotted line is lower limit of parotid.

the vessels of the alimentary tract and those of the spleen, in spite of the widespread belief to the contrary which he characterises as an erroneous impression.

The following is a brief description of the most important lymphatic glands which demand attention on the part of the meat inspector, based upon the description given by Ostertag, which in its turn follows that of Franck, and which incorporates the observations of all continental anatomists and observers. For this purpose we may divide the glands of the body into two groups : first, those of the head, the trunk, and the extremities ; and secondly, those of the thoracic, abdominal, and pelvic cavities.

(a) LYMPHATIC GLANDS OF THE HEAD, TRUNK, AND EXTREMITIES

(1) **Submaxillary Lymphatic Glands.** These glands receive the lymph from all the vessels coming from the lower half of the head, including

therefore those from the cheeks, the nose, the mucous membrane of the mouth, the tip of the tongue, the mucous membrane of the nose and the gums. The efferent vessels carry the lymph to the upper cervical glands.

(2) Other lymphatic glands in this neighbourhood lie close to the parotid, being partly in relationship to the lobes of that gland behind the articulation of the jaw. They receive lymph from the ear, the parotid gland itself, the temporal region, and from the base of the skull. Their efferent vessels, like those of the preceding group, discharge their contents to the upper cervical glands.

(3) **Upper Cervical Lymphatic Glands.** This group, sometimes spoken of as the cranial glands, is found on either side of the posterior wall of the larynx and pharynx in the region of the thyroid. They also include an extremely important group of glands in connection with the inspection for tuberculosis and other diseases, namely, the retropharyngeal glands, which are found in cattle on the posterior wall of the pharynx. The afferent vessels of all these come from the cranial cavity, the base of the skull, the pharynx, the larynx, and include those vessels bringing lymph from the two previous groups of glands above described.

(4) Another group of glands is found lying upon the upper third of the trachea. These are known as the *middle cervical glands*, the lymph from which passes to the lower cervical glands to the next mentioned.

(5) **The Lower Cervical Lymphatic Glands** are found lying immediately in front of the entrance to the thorax and upon the interior wall of the trachea. Their afferent vessels bring lymph from the middle and upper cervical glands, and include all the vessels of the neck and head, and in addition receive the lymph coming from the prescapular gland, a structure which has been mentioned as of importance in tuberculosis. The lymph from them passes on the right side to the right lymphatic trunk; while from those on the left side the afferent vessels lead to the thoracic duct.

(6) **Axillary Glands.** These glands constitute a large group which, however, are not accessible for rapid examination on the part of the inspector, on account of the fact that they are covered by the scapula and its muscles, which have to be removed in order to expose them. Their afferent vessels bring lymph from the outer wall of the thorax and from the surface of the scapula.

(7) **The Prescapular Glands.** These very important glands, termed by some writers the supercervical glands, can readily be exposed in the bovine carcase, provided that this operation is done before the carcase has set firm, after which process, if the carcase be a large and fat one, these glands are not nearly so easy to find. Their position in cattle is exactly in front of the shoulder joint, where they are covered only by the thin portion of the brachiocephalic muscle.

If the gland be enlarged, and the carcase not too fat, it can readily be felt through the fibres of this muscle, and if the incision be made at the point indicated the gland is immediately exposed lying embedded in

fat. *In cattle* and in *hogs* these prescapular glands are *single,* there being one on each side of the body; in horses they form a cluster. Their afferent vessels bring the lymph from the superficial glands of the neck, the shoulder, and the arm and forearm. *They therefore form an important guide in estimating the condition of the fore-quarters of the body.* These

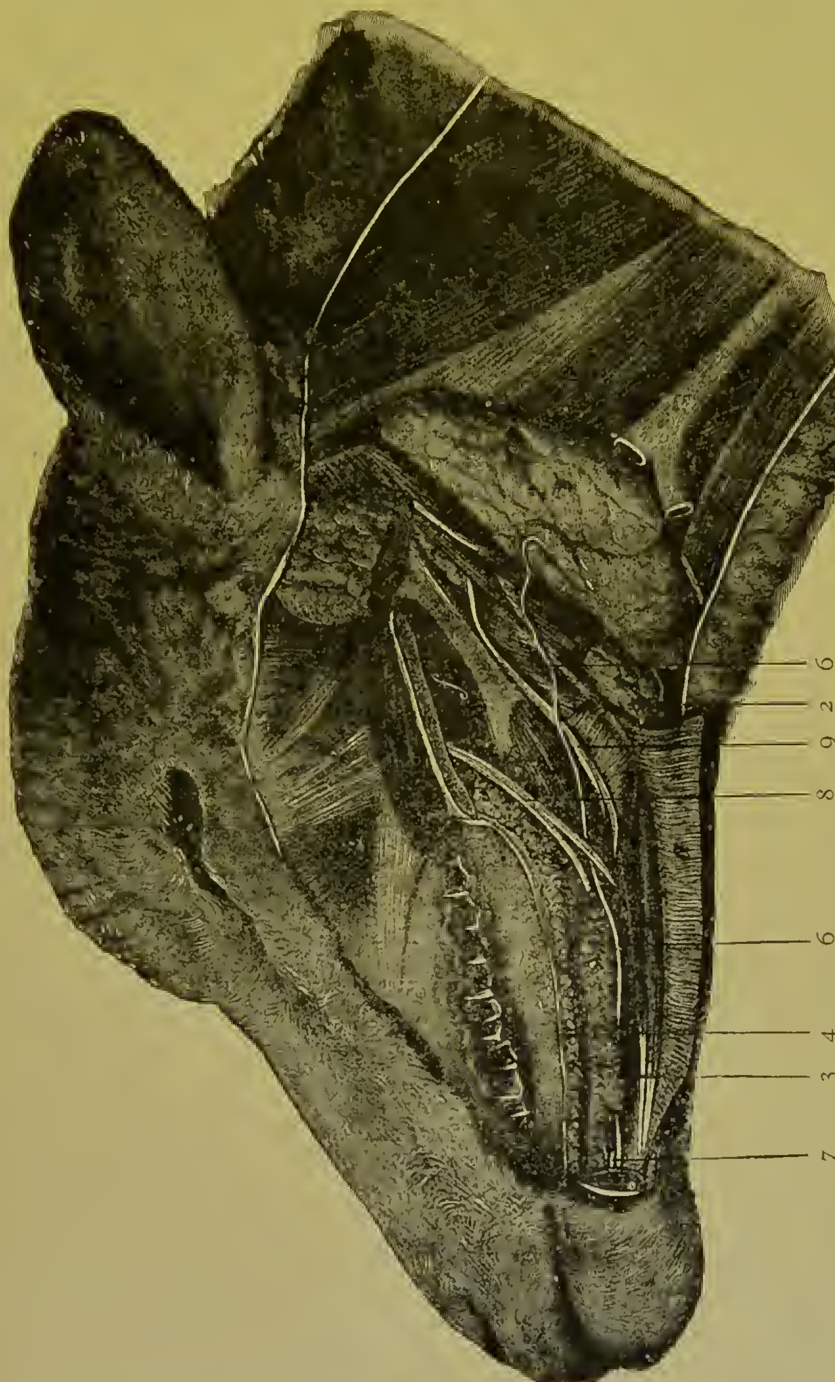


Fig. 3.—Glands of Sheep, Lower Jaw. (Ellenberger and Baum)

1. Parotid.
2. Submaxillary.
3, 4. Sublingual.
5. Palatine.
5, 6. Submaxillary duct.
7. Sublingual duct.
8. Lingual nerve.
9. Hypoglossal nerve.

a. Mylohyoideus.
b. Geniohyoideus.
c. Genioglossus.
d. Digastricus.
e. Styloglossus.
f. Pterygoideus.
g. Masseter.

glands may be somewhat difficult to expose in very fat hogs. To do so, a deep transverse incision should be made through the skin from the interior border of the neck to the nape exactly in front of the shoulder joint.

(8) **Precrural Glands.** These glands lie at the anterior border of the *tensor fasciæ latæ.* Their afferent vessels are derived from the anterior

part of the thigh and the outer portion of the abdominal wall ; the efferent vessels passing from them go to the lumbar glands. In hogs these glands are most easily exposed by an incision made into the abdominal wall in front of the femoro-tibial joint perpendicularly towards the spinal column.

(9) **Deep Inguinal Glands.** This group lies in the femoral canal, forming a covering to the femoral vessels. Their afferent vessels bring lymph from the popliteal glands and from the penis as well as from the region of the thigh. Their efferent vessels carry the lymph to the lumbar glands, but some of these vessels are distributed directly into the thoracic duct. According to some authors, these glands are not always to be found in most of the food animals, being occasionally, or even commonly, very small. Their exact position is given as being at the point at which the external pudic artery arises at right angles from the femoral artery.

(10) **The Superficial Inguinal Glands.** This group in the male animal lies at the neck of the scrotum, while in female animals it is found above and behind the udder, these being also known in the female as the *supra-mammary glands.* Their afferent vessels bring the lymph from the external sexual organs, the inferior abdominal wall, and the middle portion of the thigh. The efferent vessels from them pass in part to the deep inguinal glands or directly into the commencement of the thoracic duct.

(11) **The Popliteal Glands.** These glands lie deeply between muscles, being found immediately above the joint of the bifurcation of the heads of the gastrocnemius muscle, and are always exposed when the joint is dissected. Their efferent vessels carry all the external lymph vessels of the posterior extremity, and their efferent vessels take the lymph to the deep inguinal glands and the pelvic glands. In addition to these popliteal glands there are in hogs numerous other small glands, varying between the size of a pea and a nut in this region, a little above the tuberosity of the calcaneum. They are not usually in evidence, but in cases of generalised tuberculosis in pigs are very readily displayed.

(β) THE LYMPH GLANDS OF THE THORAX, ABDOMEN, AND PELVIS

(*a*) Thoracic Cavity

(1) A considerable number of lymphatic glands are found in relation to the upper and lower parts of the wall of the thorax, most of these glands being small in size. Those in relation to the upper thoracic wall lie either at the sides of the bodies of the vertebræ or in the intercostal spaces. These glands receive lymph from the dorsal vertebræ, the superficial muscles of the back, the intercostal muscles, and to a certain extent lymph from the diaphragm and the peritoneum ; their efferent vessels carrying the lymph from the glands to the thoracic duct. In the interior wall of the thorax a few lymphatic glands are found close to the

sternum and between the costal cartilages. These glands are none of them very large, and they are in anatomical relationship to the internal thoracic veins. They collect lymph from the *rectus abdominis* muscle, the anterior surface of the diaphragm, and from the intercostal muscles. From them the efferent vessels carry the lymph in three different directions; part of it is taken to the mediastinal glands, part into the right lymphatic trunk, and the remainder passes directly into the thoracic duct.

(2) **Anterior Mediastinal Glands.** These glands are found lying between the folds of the anterior membrane of the mediastinum. They receive lymph which comes from the heart, the pericardium, and part of the diaphragm. Their efferent vessels carry this lymph in part directly into the thoracic duct, and partly into the right lymphatic trunk.

(3) **The Posterior Mediastinal Glands.** This group of lymphatic glands lies immediately under the arch of the aorta. Their afferent vessels bring lymph from a number of sources, including the mediastinal membrane, œsophagus, pleura, diaphragm, the anterior abdominal region, and from the anterior surface of the liver. Their efferent vessels carry the lymph partly to the bronchial glands, partly to the anterior mediastinal glands, and the remainder passes directly into the thoracic duct.

(4) **The Bronchial Glands.** These very important glands are found lying on either side of the trachea at the point of its bifurcation, where they are covered partly by the aorta, and, in most animals which have been fattened, also by a certain amount of fat. The inspector in exposing these glands makes an incision from above outwards to the point of bifurcation of the trachea. Their afferent vessels bring lymph from the lungs, as well as that which has already passed through the posterior mediastinal glands, which statement is sufficient to indicate at once the extreme importance of examining all these glands in pulmonary affections. From them the efferent vessels discharge lymph into the anterior mediastinal glands, and partly directly into the thoracic duct.

The mere enunciation of the anatomical relationships of these groups of glands in the thorax will indicate at once that in every case of tuberculosis and other diseases affecting the chest they should be carefully exposed and examined.

(*b*) Abdominal and Pelvic Cavities

(1) **The Lumbar Glands.** This group is found lying partly covered by the lumbar muscles and near the bodies of the lumbar vertebræ.

Two groups of them are termed the internal iliac glands, these lying on either side between the external iliac artery and the deep circumflex iliac artery. The afferent vessels of these glands bring lymph from the organs which lie in the pelvis, from the lumbar muscles, and from the upper part of the wall of the abdominal cavity. Their efferent vessels carry the lymph directly into the thoracic duct.

(2) **The External Iliac Glands.** This group is found at the bifurcation of the deep circumflex iliac artery. Their afferent vessels bring the

lymph from the sides and lower wall of the abdomen as well as from the lateral surfaces of the femoral region, and in addition that from the external subiliac glands. Their efferent vessels carry the lymph to the group of glands just described, namely, the lumbar glands.

(3) **The Sacral Glands.** This group is found in the inferior wall of the sacrum, towards its lateral aspects. Their afferent vessels come from the upper wall of the pelvis as well as from the rectum, and their efferent vessels (like those of the last group) discharge their lymph into the lumbar glands.

(4) **The Ischiatic Glands.** These glands are not inside the pelvis, but lie on the exterior aspect of the ischiatic notch, receiving lymph through their afferent vessels from the popliteal glands, and in part from muscles in the sacrococcygeal region. Their efferent vessels carry the lymph partly to the sacral glands and, partly, as in the case of the two previous groups, to the lumbar glands, these latter of which will, therefore, be noticed to receive lymph from various sources in the posterior part of the body.

(5) **The Portal Glands.** These glands are found lying at the hylum of the liver, surrounded as a rule by a certain amount of fat.

(6) **The Splenic Glands.** These are very small as a rule and are found lying at the hylum of the spleen in the gastrosplenic ligament. If the spleen be detached from its surrounding organs the splenic glands usually remain behind in relation to the stomach.

One or two small glands are found at the hylum of the kidney, but are not readily demonstrated.

(7) **The Mesenteric Glands.** This group is by far the most important for the routine work of the inspector, since *they should be incised in every case* before the abdominal organs leave the slaughterhouse for the various purposes for which they are destined.

Their situation is between the folds of the mesentery along the concavity formed by the arch of the intestines when the latter are spread out. They vary considerably in size in the same and in different animals, some of them being quite small and rounded, while others are oval and considerably larger. In ruminants and swine one particularly elongated mesenteric gland lies in relation to the small intestine, and, in addition, in swine there is a further group of small lymphatic glands on the peritoneal attachments of the mesentery.

[For the above description of the connections and relationships of these groups of glands, we are indebted chiefly to that in Ostertag's Handbook on Meat Inspection.]

The Course of the Lymph. It is of the utmost importance that the meat inspector should appreciate the course which the lymph takes in the body, in addition to being able to expose any given gland anatomically. Only in this way can he estimate correctly the probable condition of a carcase from the appearance of the glands when exposed. In the following table we have therefore arranged these various glands in such a way that the course of the lymph can be seen at a glance, and the

gland and its corresponding area displayed readily. It will be noted that the name of every gland which appears in the right-hand column appears also in the middle column. It must do so, because the right-hand column represents the ultimate course of the lymph to the thoracic duct, or else an intermediate stage in that course. The table is practically, therefore, a diagram of the glands and their connections, a careful perusal of which ought to make these connections clear.

Tabular Representation of the Lymphatic Glands, their Corresponding Areas and Course of Lymph

1. *Glands of Head, Trunk, and Extremities*

Corresponding area.	Name of gland. (Afferent.)	Destination. (Efferent.)
Lower half of head; cheeks; nose; mucous membrane of mouth, nose, and gums . . .	Submaxillary	Upper cervical glands
Ear; parotid gland; temporal region; base of skull . .	Glands close to parotid	Upper cervical glands
Cranial cavity; base of skull; pharynx; larynx . . .	Upper cervical (cranial)	Lower cervical glands
Middle and upper cervical glands; vessels of head and neck; prescapular gland .	Lower cervical	(Right) Right lymphatic trunk (Left) Thoracic duct
Superficial neck glands; shoulder; arm; forearm .	Prescapular	Lower cervical
Anterior part of thigh; outer abdominal wall . . .	Precrural	Lumbar
Popliteal gland; penis; thigh .	Deep inguinal	Lumbar Thoracic duct
External sex organs; inferior abdominal wall; mid thigh .	Superficial inguinal (supramammary, female)	Deep inguinal Thoracic duct
External vessels of posterior extremity. . .	Popliteal	Deep inguinal Pelvic

TABULAR REPRESENTATION OF THE LYMPHATIC GLANDS, &c.—(*continued*)

2. *Glands of Thorax, Abdomen, and Pelvis*

Corresponding area.	Name of gland. (Afferent.)	Destination. (Efferent.)
(*a*) *Thoracic cavity*		
Dorsal vertebræ; superficial back muscles; intercostal muscles, diaphragm; peritoneum . . .	Glands in upper wall of thorax	Thoracic duct
Rectus abdominis; anterior part diaphragm; intercostal muscles .	Glands on interior thoracic wall	Mediastinal Right lymphatic trunk Thoracic duct
Heart; pericardium; diaphragm . .	Anterior mediastinal	Right lymphatic trunk Thoracic duct
Mediastinal membrane; œsophagus; pleura; diaphragm; anterior abdominal region; anterior surface liver .	Posterior mediastinal	Bronchial glands Anterior mediastinal Thoracic duct
Lungs; posterior mediastinal glands .	Bronchial	Anterior mediastinal Thoracic duct
(*b*) *Abdomen and Pelvis*		
Pelvic organs; lumbar muscles; upper wall of abdominal cavity .	Lumbar	Thoracic duct
Sides and lower abdominal wall; lateral femoral region; external subiliac glands . . .	External iliac	Lumbar
Upper pelvic wall; rectum . .	Sacral	Lumbar
Popliteal gland; sacrococcygeal muscles .	Ischiatic	Sacral Lumbar

BOVINE TUBERCULOSIS OF SPLEEN

A typical case showing the superficial deposit on the serous surface, the interior of the organ being, as is common, unaffected.

CHAPTER XIII

DISEASES OF SPECIAL ORGANS AND PARTS

MUSCLES; UDDER; MOUTH, TONGUE, AND PHARYNX; BRAIN AND NERVOUS SYSTEM; BONES

Introductory. In response to expressed wishes of numerous meat inspectors in various parts of the country, we now proceed to consider a number of different conditions, *under the heading of the organs respectively affected.* It is quite impossible to arrange the whole subject of meat inspection in this way, but it is perfectly possible to take each organ in turn and deal with the most common conditions which the meat inspector has to consider in connection with that organ. This we have tried to do in the following pages. It is, of course, much simpler to take each *disease* in turn, and deal fully with it, which is the usual method in most books. The inspector, however, is interested in organs first, and then the disease; not the disease first and then the organ. He wishes to be able to refer to a section on the liver, for instance, under which heading he hopes to find most of the conditions which affect that organ, and similarly with the lungs and other organs. For this reason we have dealt with tuberculosis and some other diseases by themselves, as large, general questions to which reference can be made from that point of view, and we shall now take up each part of the body in turn and draw attention to the principal morbid conditions to be encountered.

THE MUSCLES

There are but few important conditions which occur in the muscles themselves as apart from general diseases of the whole system. Of those which do, the following may be noted.

Rupture of muscle fibres here and there is not an uncommon occurrence leading to discoloration of the part from the extravasation of blood. Such areas are very conspicuous after the process of cooking.

The inspector should remember that all such local conditions are apt to undergo rapid degeneration, and the affected part should be removed.

Hyaline Degeneration. Of degenerations, hyaline degeneration is the only condition in muscle which possesses any importance of itself, and since meat in this condition keeps but badly it should be carefully looked for. Muscle in a condition of hyaline degeneration (such as may be seen in the pig) is of a greyish colour and soft consistency, and containing a considerable amount of fluid. Indeed, the œdema is so great that it allows of the perforation of the muscles under the pressure of the finger.

FIG. 1.—MUSCLE OF TRUNK OF PIG (LONGITUDINAL AND TRANSVERSE SECTIONS)

Cysticercus cellulosæ (slightly shrunk) abundant. (Preparation by S. Delépine.)

This condition, most common in swine, is found also in calves and sheep, especially in the diaphragm, abdominal and intercostal muscles.

Extensive hyaline degeneration should be considered sufficient cause for seizure of the carcase.

Inflammation which extends into and throughout the muscular tissue itself (myositis) and which is often of a rheumatic character, may produce such alterations in the meat as will call for their seizure.

Tumours of muscle are distinctly rare, except in such cases as those of secondary malignant growths all over the body.

Tuberculosis of the muscular tissue itself is an astonishingly rare condition, except in such forms of local deposit which are merely the result of the deposition of lymph on a muscle and its subsequent tubercular growth. Such masses of tubercle may be frequently seen attached to the muscles of the abdominal wall in advanced cases of tuberculosis, but it is an almost unique experience to discover tubercular nodules inside a muscle itself as the result of a blood-stream infection.

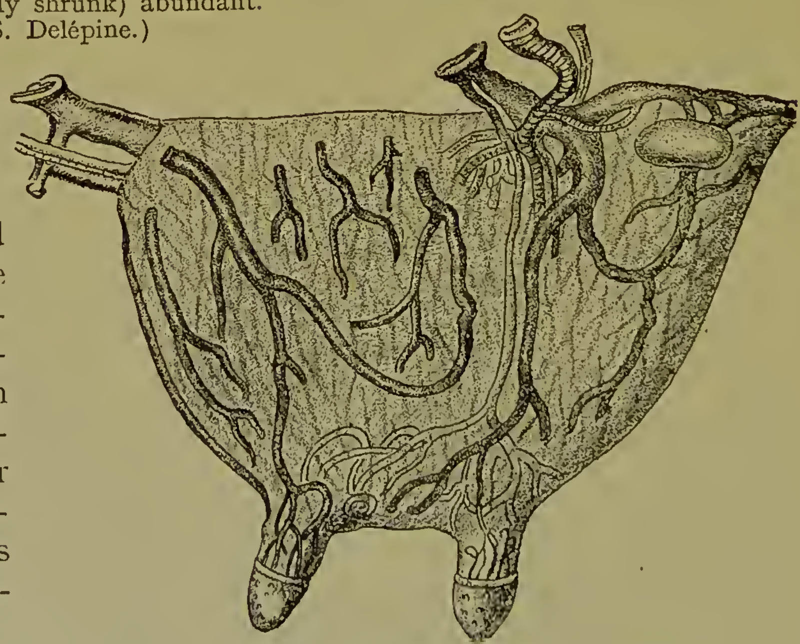


FIG. 2.—BOVINE UDDER WITH BLOOD-VESSELS

Tubercular glands

lying between muscles do not, of course, come under this category.

Actinomycosis and botriomycosis are interstitial inflammations with large fibrous masses in connection with muscle.

Of the animal parasites which pass one or other stage of their life's stages in the muscles of food animals, and which may be transmitted to human beings eating infected meat, we have to note three: *Cysticercus*

Fig. 3.—Bovine Tuberculosis
Cow's udder, with marked deposit of tuberculosis along the lower border, practically one-third of the depth of the udder. Note the infected lymphatic gland at the top. (Dr. Hope's Collection.)

bovis or measly beef; *Cysticercus cellulosæ* or measly pork; and *Trichina spiralis*. These parasites, together with their appearances produced, are discussed in a separate chapter.

THE UDDER

The most important changes occurring in this gland are those of inflammation or mastitis, tuberculosis, and actinomycosis. Inflammatory conditions are extremely common in the cow, doubtless because of the high development to which the mammary gland has attained in the selected breeding of cattle for the production of milk. Two forms of inflammation particularly call for attention; one in which the secreting gland tissue itself is affected, and the other in which the connective tissue of the organ is the main seat of the change. The former is usually a very simple process which does not much affect the general condition

FIG. 4.—ADVANCED TUBERCULOSIS OF UDDER (COW)
(Dr. Hope's Collection.)

of the animal. These inflammations are practically local, and it is only when the inflammation of the gland is associated with septic conditions (such as numerous abscesses) that the meat inspector requires to consider the condition of the carcase with reference to this gland. In those cases his judgment will be based on the general principles laid down for the treatment of suppurative and pyæmic conditions.

Tumours of the mammary gland are extremely rare in our food animals, with the exception of the papilloma which occurs on this surface and is quite unimportant.

Tuberculosis. Tubercular mammitis is frequent in cattle, affecting from 2 to 4 per cent. of all tubercular cows. It occurs in two forms, in the first of which the tubercular change is found in large nodules up to

Fig. 5.—Tuberculosis of Udder
(Dr. Hope's Collection.)

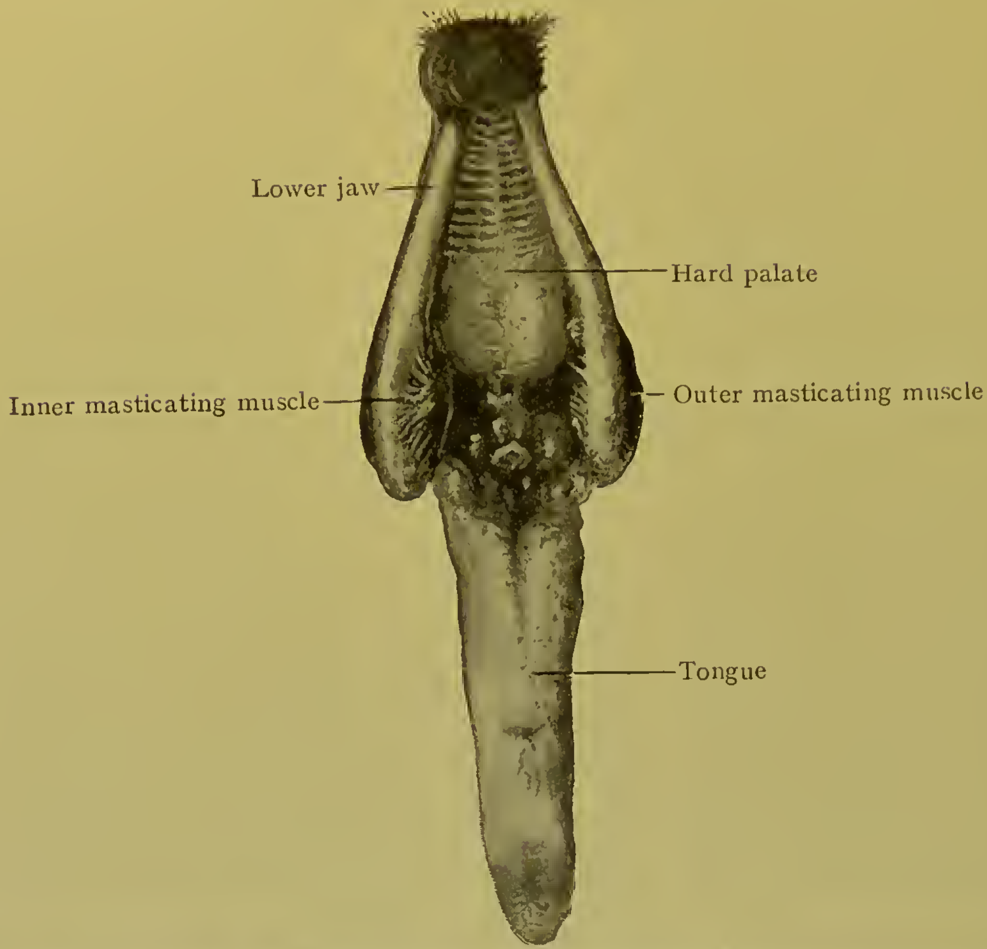


FIG. 6.—BOVINE HEAD AND TONGUE

FIG. 7.—SIDE OF FACE AND NECK OF A COW AFFECTED WITH ACTINOMYCOSIS OF LIPS (S. Delépine.)

the size of an orange, which are hard and firm with areas of caseation and calcification. The second form is more diffuse, and leads to great enlargement and induration of one or more quarters of the organ. It is rare that the whole gland is equally affected. Whenever tuberculosis occurs here the supra-mammary glands are similarly affected.]

Actinomycosis. This disease is not uncommon in the udder of cattle, though, on the other hand, it is rare in swine, in which it occurs in the form of a cold abscess rather than a solid growth.

Fig. 8.—Section through Tongue and Lower Lip of a Cow affected with Actinomycosis of the Lips, Gums, and Anterior Part of the Floor of the Mouth
Actinomycosis abundant in lesions. (Preparation by S. Delépine.)

MOUTH, TONGUE, AND PHARYNX

The most important lesions affecting these parts are those which are associated with various inflammatory conditions, foot and mouth disease, actinomycosis, tuberculosis, anthrax, and septicæmia.

Inflammations. A number of inflammatory conditions occur in the buccal cavity, attacking the mucous membrane, the tonsils, the tongue itself, and the glands. These may be caused by accident, injurious acids and alkalies, and faults in connection with the teeth ; and the changes in the tissue involved will, as a rule, be so obvious as to indicate either the condemnation of the whole head or, possibly, only the exclusion of the tongue.

The mucous membrane of the mouth frequently suffers from infection of actinomycosis, in which condition there are numerous small nodules, in and upon the membrane. In septicæmias there is frequently a

swollen tongue with considerable œdema. The mucous membrane of both the mouth and the pharynx shows croupous inflammation in the formation of a false membrane in the so-called diphtheria of calves and fowls.

The Tongue. Actinomycosis is certainly the most important condition with which the inspector has to deal in this organ, this being the most frequent site of the lesions in cattle. The most frequent spot for its

FIG. 9.—TONGUE OF COW

Transverse section through posterior fifth of tongue (*Actinomycosis bovis* abundant). Actinomycosis grains visible in the section of actinomycotic nodules. (Preparation by S. Delépine.)

development is on the dorsal surface, between the body of the tongue and the commencement of the tip. In quite a number of cattle examined on the Continent from this point of view (9.1 per cent.), alterations in the epithelium on the dorsal of the tongue were found to be present at the spot affected, and of these 71 per cent. of the total were found to be early stages of actinomycotic infection. There is a general absence of the superficial epithelium at the spot, with small nodules or abscesses underneath, in which the ray fungus is found. In those in which the

lesion was not of this nature the abscesses were due to the organisms of suppuration. This characteristic affection of the tongue in cattle is associated with their peculiar method of feeding, in which these animals retain for some time portions of the food on that part of the tongue between its fixed and movable points. On the other hand, other authorities advance the opinion that the anatomical structure of the tongue itself is responsible for the selection of this site, and particularly it has been held that the disappearance of the filiform papillæ and atrophy of the mucous membrane just in front of the dorsal ridge of the tongue in old cattle, renders the structure at this point much more liable to penetration by some foreign substance upon which lies the infective agent than it otherwise would be. This is the view of Brauer, who also established the fact that actinomycosis is more common in older cattle in proportion to the age.

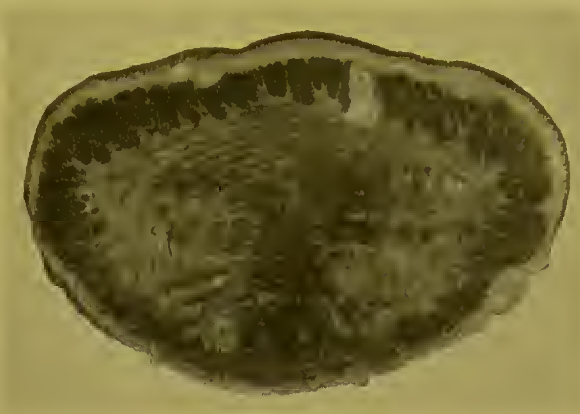


FIG. 10.—TONGUE OF A COW
Transverse section near the tip (anterior $\frac{1}{5}$) showing young actinomycotic nodules. (Preparation by S. Delépine.)

Besides this form just described, actinomycosis of the tongue occurs

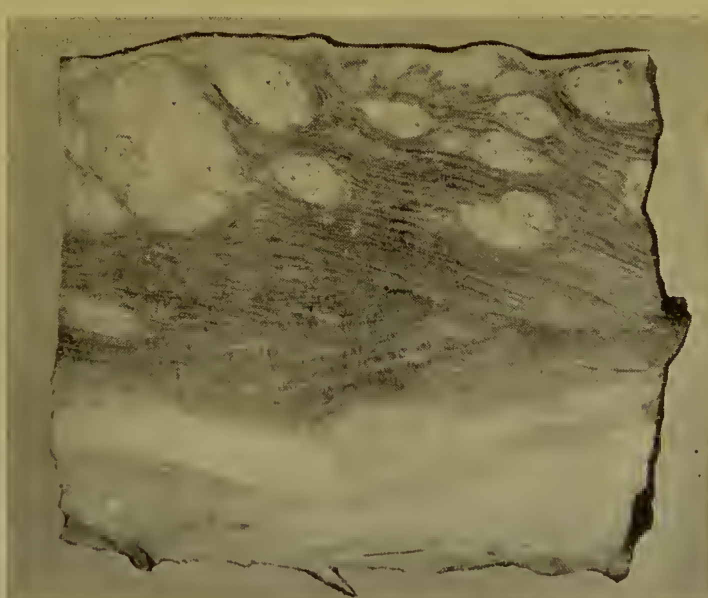


FIG. 11.—TONGUE OF A COW: ACTINOMYCOSIS
Longitudinal lateral section, posterior part of middle $\frac{1}{3}$ of tongue. (Preparation by S. Delépine.)

in the shape of numerous marbled nodules scattered throughout its substance, which may readily be detected by the fingers in the freshly

slaughtered animal, and which under the microscope exhibit the typical structure of actinomycotic nodules.

Lastly, there is the diffuse form of the disease commonly known as "wooden tongue," in which the whole organ or a large portion of it becomes extremely hard and dense from a progressive proliferation of its connective tissue at the expense of the muscle cells, which gradually disappear. Scattered in and amongst this dense fibrous mass may be found small colonies of the parasite as well as larger ones. Owing, however, to their subsequent degenerations they may be somewhat difficult to demonstrate. Occasionally, on the surface of the tongue, this disease appears as a localised rounded mass, somewhat like a mushroom. This mass consists of hard connective tissue with the parasite scattered through it. The only other condition which may be mistaken for a diffuse actinomycosis is that produced by chronic interstitial myositis or glossitis, a long-standing inflammation of the tongue substance, generally produced in the first place from irritation from a defective tooth, and frequently showing on the surface ulcerations at the point of origin.

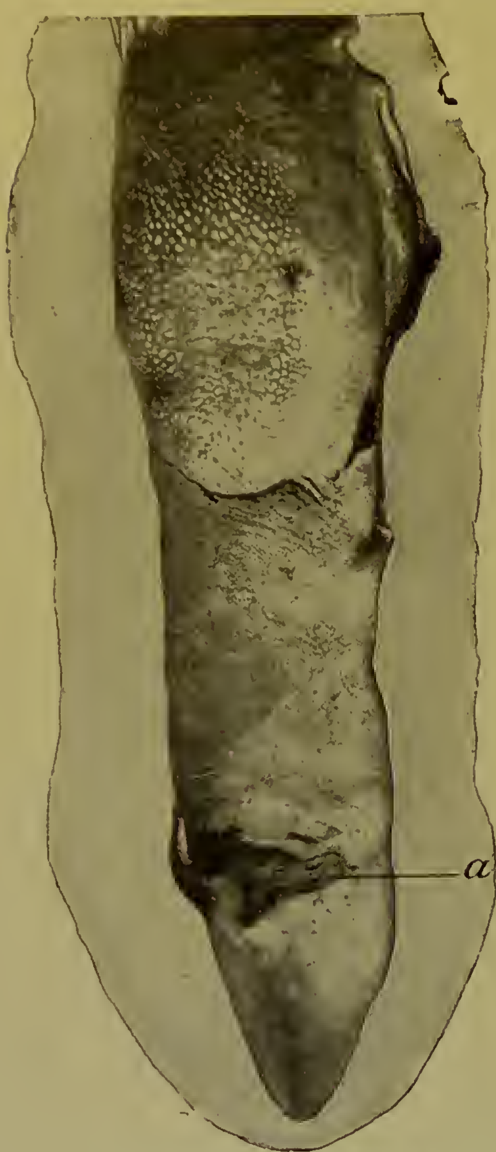


Fig. 12.—Bovine Tongue in Foot and Mouth Disease
a. Ulcer.

FOOT AND MOUTH DISEASE

Owing to the fact that this condition is responsible for great financial loss and utter disorganisation of the meat industry in any centre in which it occurs, it is absolutely necessary that the meat inspector should become thoroughly familiar with its signs and symptoms. Moreover, the disease is spread by food animals chiefly, and it is thus comparatively an easy matter for cattle markets and slaughterhouses to become centres of infection, and an extremely difficult matter subsequently to render them free from danger. The disease occurs practically only in hoofed animals, of which cattle and swine are chiefly affected, and sheep occasionally. The appearances produced are, in the first place, those of clear vesicles which form on the nasal septum, on the border of the upper jaw, at the tip and on the lateral surfaces especially of the tongue, as well

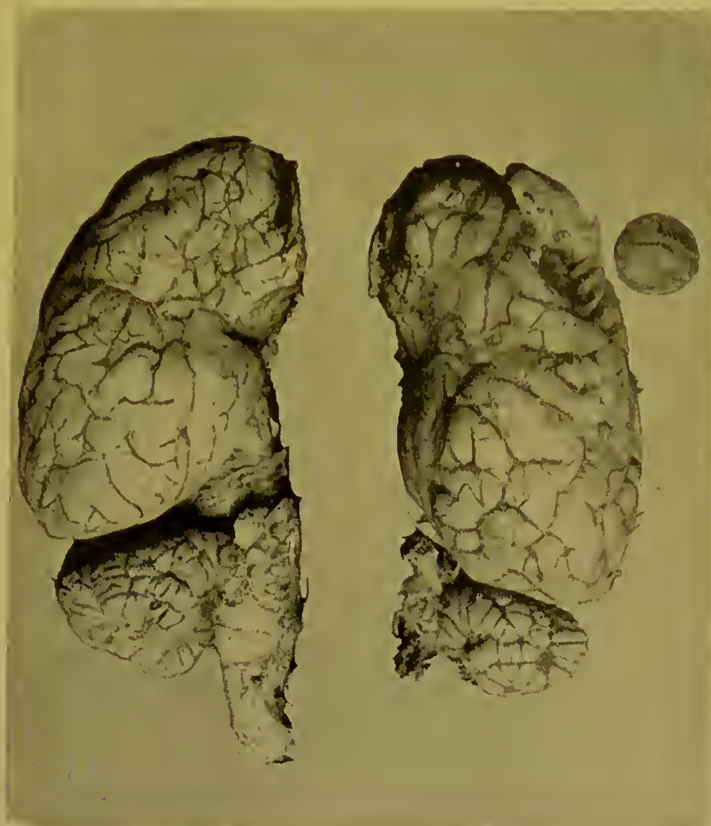


FIG. 13.—BRAIN OF SHEEP WITH CŒNURUS IN ANTERIOR PART OF LEFT HEMISPHERE OF THE CEREBRUM

Some of the grey and white matter partly covering the cyst has been reflected forward and the parasitic cyst drawn out of cavity and left near the opening of that cavity. (Preparation by S. Delépine.)

as on the mucous membranes of the mouth. (We are not here concerned with the appearances in the cleft of the hoof.) These vesicles presently rupture, leaving an ulcerated surface which heals in the usual way. In the meantime, however, the ulcer which marks the spot of the ruptured

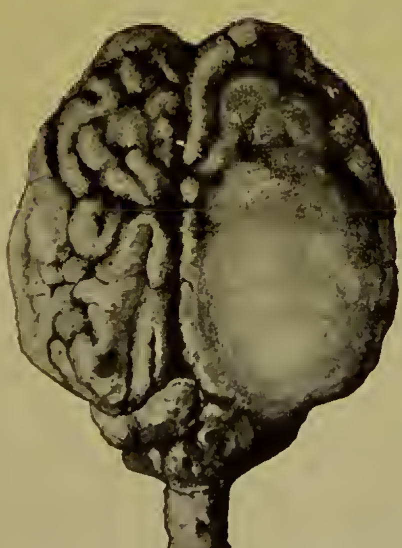


FIG. 14.—CYST OF CŒNURUS CEREBRALIS IN BRAIN OF SHEEP. ("STURDY.")

FIG. 15.—TÆNIA CŒNURUS OF DOG

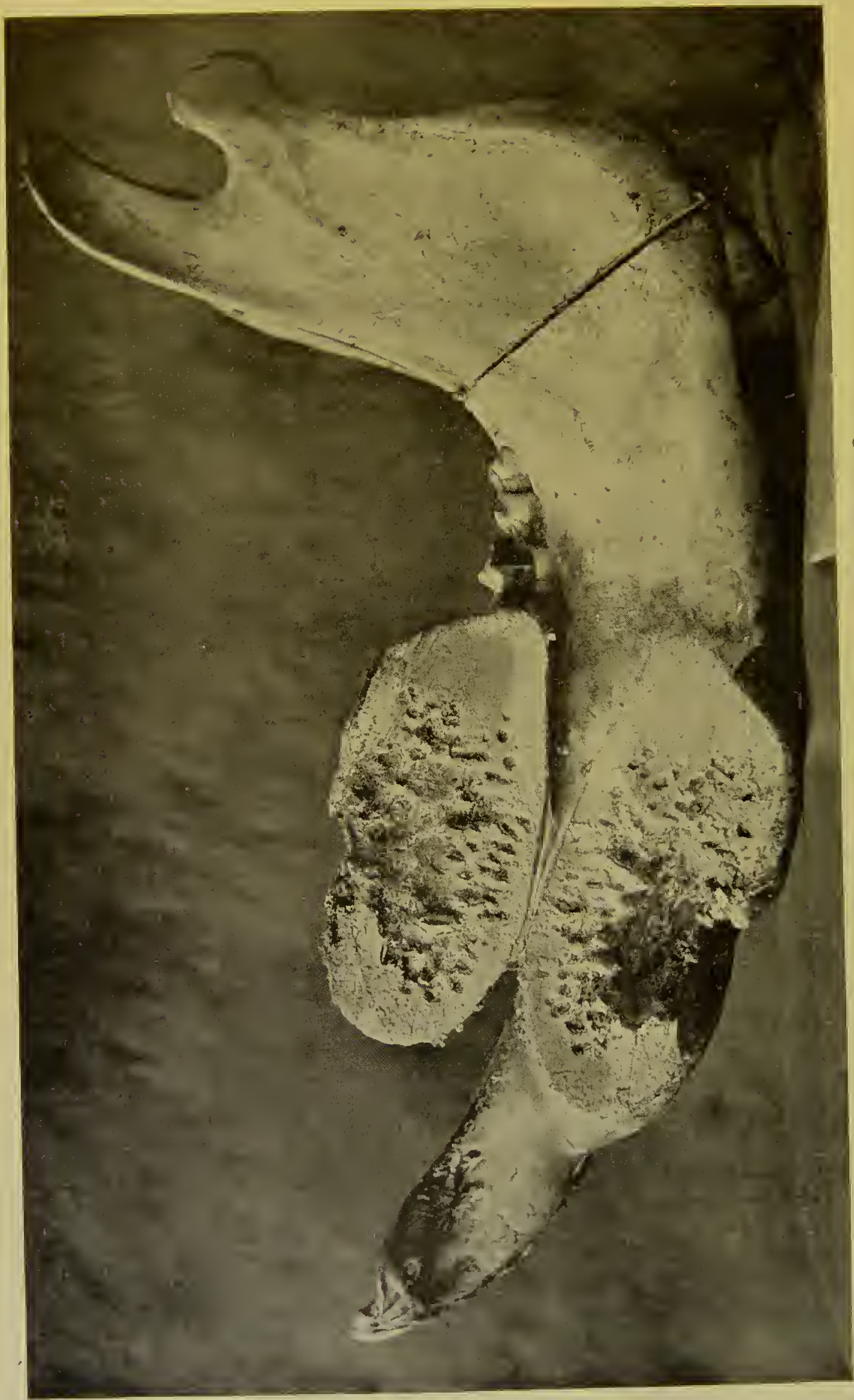


Fig. 16.—Actinomycosis. Section of the Jaw of Ox
(Dr. Hope's Collection.)

vesicle is an extremely characteristic lesion, showing a sharply defined margin between itself and the surrounding healthy tissue of the tongue.

All animals affected with foot and mouth disease must be condemned as unfit for human consumption, since the disease is transmissible to man. It is true that continental and other experts maintain that the meat itself possesses no properties of a harmful nature, and in some countries it is therefore deemed sufficient to exclude only from sale the affected portions of the body. This is one of those economical procedures which in this country does not meet with approval, and where the importance of stamping out an outbreak is of such a serious nature as it is in Great Britain more stringent measures are certainly advisable in the interests of the whole meat industry.

Tuberculosis. It need only be mentioned here that tuberculosis is not uncommonly met with in the region of the mouth as a primary affection of certain glands, especially the retropharyngeal glands in cattle and the tracheal glands in swine. The latter glands should always be carefully inspected in all swine carcases for tuberculosis, and the common generalisation of the disease in those animals remembered.

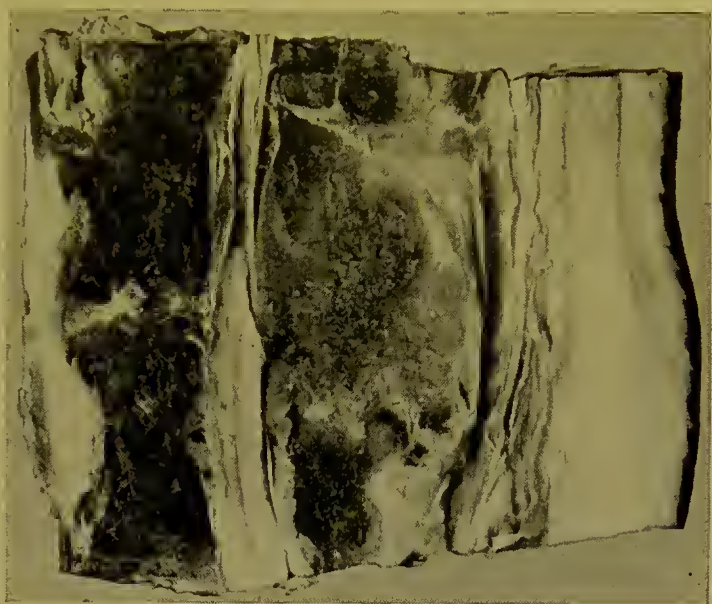


FIG. 17.—DORSAL VERTEBRÆ OF PIG
With tuberculosis affecting chiefly the spinous processes and the connective tissue below the bodies of the vertebræ. (Preparation by S. Delépine.)

BRAIN, SPINAL CORD, AND NERVES

Very few conditions of the nervous system call for the attention of the meat inspector, since none but septic or parasitic conditions render the meat of the animals injurious. In the brain are found parasitic cysts, especially those in sheep which are the cause of staggers, namely, *Cœnurus cerebralis.*

Other parasitic conditions similarly occur in the brain, but are of very little importance. The same cyst already mentioned occurs in the spinal cord of sheep.

Occasionally neuromata are found upon nerves of sheep, in the facial nerve of cattle or the intercostal nerves, but these are of no importance.

THE SKELETON

Rickets and Osteomalacia. Several conditions in the skeleton may attract the attention of the inspector, and of these the most frequent, perhaps, is that of *rickets* occurring in young animals, especially swine. There is no special reason, as far as we know, why the meat of animals suffering from rickets should be withheld from sale, unless the disease extends over the whole body and is accompanied with gastric disturbances and fever, in which case the carcase should be condemned. In the curious condition of the bones known as *osteomalacia*, which is a disease of old age, the meat inspector's judgment must depend upon the presence or absence of emaciation. If this be present to any marked extent the carcase should be condemned as unfit.

Fig. 18.—Bovine Tuberculosis affecting the Body of a Vertebra

Fractures. The attention of the inspector will frequently be drawn to the presence of fractured bones, especially in animals which have been delivered from a distance by train. Also the ribs of all animals are apt to sustain fracture readily. The importance of the injury lies not so much in the fracture itself, but in the fact that it sets up an area of inflammation at the point of fracture, which of necessity causes a degeneration of the meat in the immediate neighbourhood. Moreover, the wound which caused the fracture is very apt to be a septic one, in which case suppurative organisms are introduced which may render a large portion or even the whole of the carcase unfit for food.

Fig. 19.—Head of a Steer, showing Actinomycosis of the Jaw

FIG. 20.—ACTINOMYCOSIS. ENLARGEMENT AND ABSORPTION IN JAW-BONES OF OX
(Leighton.)

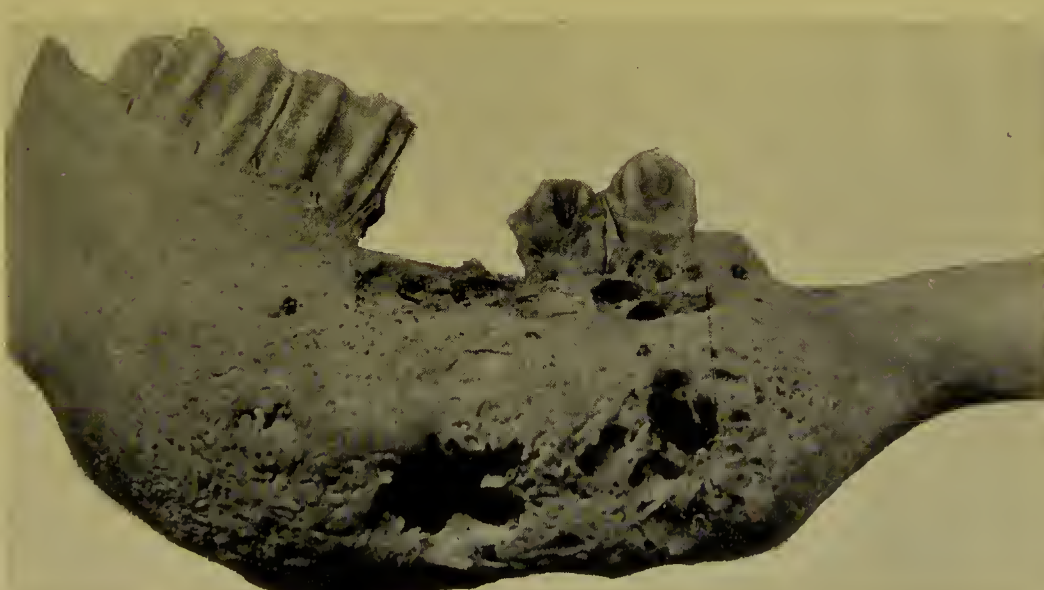


FIG. 21.—ACTINOMYCOSIS IN JAW OF OX
Note the absorption of bone from rarefying osteitis. (Leighton.)

The only diseases of bones which need be mentioned are those of tuberculosis, actinomycosis, and parasites.

Tuberculosis of bones is most common in cattle and swine, affecting the vertebræ, the breast-bone, or the ribs especially. In all cases of advanced tuberculosis the inspector should glance at the vertebræ and the sternum in order to determine the presence of tuberculosis in the bones, which takes the form of softened areas or actual cavities. In the ribs a thickening will be observed at first. Actinomycosis attacks chiefly the jaw-bones of cattle, generally the lower jaw, but sometimes the upper.

Hydatid cysts occur as a rarity in bones.

In the illustration (Fig. 20) we have a typical case showing the effects of actinomycosis on the two lower jaw-bones of a cow. The illustration represents very much the condition of the bone which would be found in such a case as that of the head in Fig. 19. Probably the tongue was also affected in the usual way, namely, very much enlarged and containing hard fibrous nodules, especially in its more superficial parts. As far as the bones are concerned it is the upper and lower jaws that are most commonly affected. The parasite finds its way into the substance of the bone through an imperfect tooth, though possibly in some instances also by direct infection through the lymphatics. The bones themselves become enlarged and swollen, as is seen in the illustration, and a good deal of tissue is actually destroyed, leaving sinuses here and there, from which is discharged material like pus. When all the soft parts are cleared away cavities left in the bones can be well seen, as in the case illustrated, the process is really one of a rarefying ostitis. Fig. 21 is taken from one of the same specimens illustrated in Fig. 20, but has been enlarged in order to show still more distinctly the amount of destruction of actual bone tissue which takes place.

An illustration of the same disease also affecting the jaw of an ox is seen on page 976, which is that of a specimen in the collection of Dr. Hope, of Liverpool.

Fat Necrosis. A peculiar condition affecting the fat in swine is occasionally encountered by the meat inspector, and which is known as fat necrosis. As a rule the fat which exhibits this condition is that which is found in the near neighbourhood of the pancreas, although it also occurs in fat elsewhere, for example, in various parts of the peritoneal cavity, in the fat surrounding the kidney, and in that of the pelvis, as well as that of the abdominal wall.

It is generally believed that this fat necrosis follows upon some pathological condition of the pancreas, probably that of the ferment of the pancreas, the normal function of which is to split up fats in the intestine, only in this condition it has been acting upon the ordinary fat tissue of the animal. The result of this ferment action is the splitting up of fat into glycerine and fatty acids, the former of which is readily absorbed and the latter combines with the organic salts of the fat to form a soap. The result is the production of opaque pinkish lesions in the fat, which vary considerably in size, and are generally more or less rounded in shape, being somewhat more firm in consistence than ordinary fat.

CHAPTER XIV

DISEASES OF THE RESPIRATORY TRACT AND HEART

The Respiratory Tract. Under this head we have to consider the morbid processes which are found in the trachea, the bronchi, the lungs themselves, the pleura, and the glands associated with these structures. There is very rarely anything in connection with the upper air passages which calls for the interference of the meat inspector apart from tuberculosis and actinomycosis. Both these diseases may attack the nasal mucous membranes, the larynx, and the mucous membrane of the trachea in cattle particularly. As a result there will be similar processes in other parts of the respiratory tract, and the meat inspector will have to deal with the whole of the respiratory organs as one.

Practically all the important lesions which call for attention in this part of our work are connected with the lungs themselves, the pleuræ and the glands, and the processes which call for most notice are tuberculosis, the various forms of inflammation which attack the lungs, and parasitic cysts.

Tuberculosis. Anatomical Conditions. ' The anatomical changes in bovine tuberculosis are mostly found in the lungs (phthisis) and in the serous membranes of the large cavities of the body (grape disease). In Germany the expression Perlsucht (pearl disease) is used to signify tuberculosis of the pleuræ and peritoneum, and corresponds, more or less, to the English term "grape disease." In about half of all the cases the lungs and the serous membranes become simultaneously affected; in about a third, the lungs alone; and in about one-fifth, the serous membranes only. When the lungs and serous membranes are attacked their respective lymph glands always become affected at the same time. In constitutional general tuberculosis, all the other organs of the body may show tubercular changes, which, however, may be restricted even to one organ.

(1) In the *lungs* we find, first of all, circumscribed caseous pneumonic foci of various sizes, which develop from a catarrhal pneumonia, with atelectasis (imperfect expansion) of the alveoli and bronchioles, emigration of leucocytes, and accumulation of large epithelioid cells in the interior of the alveoli (desquamative pneumonia), and subsequent caseation or suppuration of the affected parts of the lungs. This gives rise to the formation of caseous foci and cavities with yellowish, caseous, crumbling, and greasy or purulent contents. These changes are accompanied by chronic indurating inflammatory processes in the interstitial

tissue of the lungs. These processes appear chiefly in the neighbourhood of the caseous foci and miliary tubercles ; and manifest themselves by an interstitial new growth of connective tissue, and carnification and shrinking of the lung tissue, which sometimes shows an almost cartilaginous or flesh-like thickening and even complete calcification, and consequently offers a certain amount of resistance when it is being cut through. Freidberger and Frohner summarise the changes thus:

The Presence and Spread of Nodules. "Another kind of tuberculosis of the lungs manifests itself, in the presence of the miliary tubercles, as nodules, varying in size from a millet-seed to a pin's head. They are pale yellow, of moderately firm consistence, and are only slightly translucent. They are usually spread in great numbers, either over the surface of the lungs or prominently on the surface of the section ; and at first are surrounded by thoroughly healthy lung tissue. Later on, these nodules become caseated and calcareous in their centre. Large tubercular nodules are frequently formed by the accumulation of several of these miliary tubercles, which, in old standing cases, may undergo caseation or calcification in their interior.

"The bronchial mucous membrane is often in a state of chronic catarrh, in which greater or less bronchiectasis (dilatation of the bronchi) is not rare. Also, tubercular ulcers and miliary tubercles may occur in the bronchial mucous membrane and in the laryngeal mucous membrane ; the ulcers being distinguished by thickened, turned-up edges, and the miliary tubercles by the fact of their being arranged in rows. The tubercles usually spread from the bronchial mucous membrane to the peribronchial connective tissue (*bronchitis* and *peribronchitis nodosa*) and also to the lung tissue. Sometimes tuberculous new growths are found in the larynx, also ulcers, nodular hyperplasia of the mucous membrane, with infiltration and abscess-formation in the sub-mucous tissue, the parachondrium and the laryngeal muscles.

"The bronchial glands are always swollen, enlarged, and infiltrated with miliary tubercles. Later on, they become caseous and calcareous. On the pleuræ there may become developed a circumscribed, chronic, adhesive pleuritis, which is followed by adhesion of the lungs to the thoracic wall. Sometimes the lungs show at the same time other specific changes, such as those caused by echinococci, pleuro-pneumonia, &c."

Tubercles in Varied Forms. "(2) Tuberculosis of the pleuræ and peritoneum ('grape disease') begins with the formation of very minute, light grey, translucent nodules ('grapes') which are at first smaller than even a grain of coarse sand, and give rise to the granulated condition of the surface of the pleuræ and peritoneum. An abundant new growth of connective tissue forms round these tubercles ('grapes') with greatly increased vascularity of the serosa, so that the tubercles are, as it were, imbedded in a frame of connective tissue.

"On account of the confluence of several of such tubercles and the simultaneous proliferation of the connective tissue stratum, nodules,

varying in size from a lentil up to a pea, now form partly on the visceral and partly on the parietal membrane, and may finally become as large as a hen's egg or as a man's fist. At first they are of a soft, juicy, gelatinous consistency, and of an orange colour, and, on a section being made, often show a dark red centre. Later on, they become harder and firmer, assume a fibrous or connective-tissue-like consistency, and acquire an uneven nodular surface, so that they grate on being cut through. Or they undergo caseation or calcification in their centre, which then consists of a brittle, mortar-like, grey-yellow substance. In this more advanced state, the colour of the tubercles is light grey, ash-grey, or bluish white. These tubercles ('grapes') assume very characteristic forms. By large numbers of them being variously grouped together, they may present a villous, wart-like form, or racemose appearance; or they may take the shape of a cauliflower or mulberry. Sometimes they have a broad base, at other times they are pedunculated or shaped like a pendulum or polypus. They may cover the entire surface of the serous membrane, and may become enormously increased in number. These tubercular new growths frequently attain a weight of from 66 to 88 lb., and even more. The individual nodules have, at this stage, either grown firmly together, or have become united by bands or threads of connective tissue.

Fig. 1.—Head of Cow with Tuberculous Submaxillary Lymphatc Gland

Tubercle bacilli present. (Preparation by S. Delépine.)

"The anterior and posterior mediastinal glands become enlarged in the same way as the bronchial glands. They become infiltrated with miliary tubercles, indurated or caseous, and changed into tumours of greater or less size, even up to half a yard long. The enlarged mediastinal glands frequently enclose and compress the œsophagus."

The Affected Glands. "(3) Besides the bronchial and mediastinal glands, a considerable number of the other lymph glands of the body usually

undergo tubercular changes in the manner described. On the head, the glands usually affected are those of the larynx and the lymph glands of the parotid region ; on the neck, the upper (retropharyngeal), middle, and lower cervical glands ; in the anterior extremities, the glands of the shoulder (glandulæ cervicales superficiales hom.), prepectorial glands (glandulæ axillares), and brachial glands, in the posterior limbs, the inguinal glands, iliac glands (glandulæ iliacæ externæ hom.), and popliteal glands ; on the udder, the pudic glands (supramammary glands) ; on the croup, the external pelvic glands ; in the thoracic cavity the intercostal and sternal lymph glands, and the bronchial and mediastinal glands ; in the abdominal cavity, the glands of the mesentery, lumbar region, liver, spleen, kidneys, &c. The affected glands may sometimes attain a very large size" (Friedberger and Frohner).

THE LUNGS

Inflammation of the substance of the lung tissue, the disease known as *pneumonia*, may be produced in the domestic animals as in human beings by a large number of causes of a very varying type.

Causes of Pneumonia. Theoretically considered, the various forms of pneumonia may arise from the following distinct causes :

(1) Direct spread from a neighbouring tissue.
(2) From traumatic causes including foreign bodies.
(3) From mechanical irritation of inhaled particles.
(4) From the action of gases.
(5) From the presence of parasites, chiefly worms.
(6) From specific microbes.
(7) From fungi.

Of all these various causes of pneumonia by far the most important are those which result from a direct spread of the inflammatory condition from one part to another, such as the condition which results from the spread of a capilliary bronchitis to the terminal air cells ; and, secondly, that form of pneumonia which is known as croupous or lobar pneumonia, which is a distinct infective fever. These two diseases, the former of which is commonly known as broncho-pneumonia, represent the two main types of inflammatory conditions which are met with in the lungs ; and it is important to bear in mind the very different pathological condition present in the two types.

Broncho-pneumonia. In the first type, that of broncho-catarrhal or lobular pneumonia, we have to deal with an inflammation which attacks a small area of the lung tissue by itself without of necessity involving any large part of the organ, and this area is usually found to correspond to the termination of a minute bronchiole. In such a pneumonia there may be one or very many such small areas in a state of inflammation, these being scattered throughout the organ irregularly, and exhibiting at one and the same time all the various stages of the in-

BOVINE TUBERCULOSIS

Lungs and bronchial glands (incised) showing typical lesions.

flammatory process. Thus, in one small inflamed area, the inflammation will be in the earliest stage, another will be more advanced, while in a

Fig. 2.—Lung of Cow. Tubercular Broncho-pneumonia

Tubercle bacilli abundant. (Preparation by S. Delépine.)

third the process will have terminated. For this reason this form of broncho-pneumonia is one which may continue to exist for a considerable time, according to the number of small areas attacked and the intervals which elapse between the commencement of the process at each spot.

Lobar Pneumonia. The other principal type of pneumonia known as acute croupous or lobar pneumonia is a very different disease indeed. It is caused by the infection of one or other definite microbes which produce a condition which corresponds in all its main features to that of other specific infective fevers. As far as the lung itself is concerned,

the outstanding feature of lobar pneumonia is the fact that a large portion of one lung, or the whole of a lung, or portions of both lungs, become affected at *one and the same moment*, and the disease runs a definite course more or less, being at the same stage at the same time in the whole of the affected portion. For convenience of pathological description the stages of this disease have been divided into four, namely, those of (1) congestion; (2) red hepatisation; (3) grey hepatisation, and (4) resolution. It would be beyond the scope of this work to enter into minute details of the pathology of these various stages, concerning which a word or two will be sufficient. In the first stage, that of congestion (what is known as congestion of the lungs), the affected portion of the organ is red on account of the increased quantity of blood which is present. The condition may last from thirty-six to forty-eight hours, at the end of which time an exudate of serum has been poured out from all the dilated vessels into the air spaces, completely filling them up. It is, of course, obvious that whatever portion of the lung is so filled is at the same time rendered useless for purposes of respiration. This stage then passes into that of hepatisation, in which the exudate becomes coagulated and the portion of lung affected is practically solid. It is about the same consistence as liver tissue, from which fact, and from that of its general appearance, it takes its name. A portion of hepatised lung at this stage if placed in water will be found to sink, there being no air at all in it. After several days, usually seven or eight, the disease is at its height, and if a sufficiently large portion of lung or lungs be involved, there comes a critical period, when, if the animal is to live any longer, the solidified portion of lung tissue must once more allow of the entrance of air and blood, or else death ensues. It is at this stage that the condition known as grey hepatisation is found, during which the affected part loses its redness and becomes more pale,and the solidified portion degenerates into semi-liquid condition. Whether this so-called grey hepatisation is a necessary stage in the history of lobar pneumonia is a doubtful point, it being regarded by some as a post-mortem change of a degenerative nature occurring only after death.

Should the animal successfully tide over the stage of hepatisation, which will depend principally upon the success or failure of the heart's action, the final stage of resolution is entered upon, during which the blood once more begins to circulate through the affected lung and the exudate is partly absorbed and partly coughed up, the lung returning in time to its normal condition.

These two leading types of pneumonia, though theoretically quite distinct from each other, are often found to be present together, and still more frequently to be modified by various other conditions which affect the lung, especially tuberculosis. The condition known as tubercular broncho-pneumonia has been referred to already.

Judgment in Pneumonia. The point to be considered here is the judgment of the meat inspector with regard to a carcase in which the lungs have been found to be pneumonic, and it may be said that,

as far as we know at present, pneumonia does not necessarily render the meat unfit for consumption unless the carcase exhibits the general condition of fever, or the pneumonia is caused by one of the organisms of the infective granulomata. Ostertag states that the meat of cattle suffering from pleuro-pneumonia has been eaten repeatedly without any ill effects, a fact which has led to a special Act in Germany which allows of the consumption of meat from animals suffering from pneumonia. He also states that, in spite of the impression that the meat of swine may be infected with swine plague, there is no evidence to support that view. He concludes that infectious pulmonary inflammations behave in this matter exactly as they do in acute infectious diseases of the domestic animals, such as rinderpest, blackleg, and swine erysipelas, which are not transmissible to man.

Pneumonia with Complications. The forms of pneumonia in which, however, there is a distinct degeneration of the meat of the animals affected, and in which there may be considerable danger to health from its consumption, are those which are associated with pyæmia or septicæmia. In both these conditions pneumonia is apt to occur, and both forms of pneumonia are also apt to become the seats of suppuration.

It is, of course, quite obvious that lung tissue which is in a state of either lobular or lobar inflammation is thereby rendered less resistant to the action of the organisms of suppuration which often supervenes. Traumatic pneumonia also is likely to be of this type owing to the presence of the same organisms at the time of the injury.

CONTAGIOUS PLEURO-PNEUMONIA OF CATTLE

This disease, which, as far as the lungs are concerned, takes the form of a progressive inflammation of both lung tissue and pleura, is generally restricted to one side only, most commonly the left. The chest cavity itself frequently contains a considerable amount of fluid exudate together with fibrous adhesions, the pleura itself being thickened and having a thick deposit of yellow organised lymph. In the early stages small areas alone are found affected, but as the disease progresses a large portion of the lung becomes involved, and even both lungs may exhibit actual consolidation.

By far the most striking characteristic lesion is the immense thickness of the interlobular connective tissue as well as the tissue around the bronchi. This interlobular affection is a distension of all the lymphatic vessels, which contain a straw-coloured fluid which exudes from them. At the same time, there is considerable congestion and thrombosis of the blood-vessels. The lobules of the lungs exhibit very varying colours, according to the stage at which the inflammation is. Thus a cross-section through a portion of the affected lung shows what is termed the "marbled" appearance, the streaks in the marble being the dilated septa and the colours within the lung tissue in various stages of the pneumonic process. These are seen to be either red if congested, darker when

hepatised, or yellowish or grey when degenerated. In cases which are of old standing there are patches of dead tissue around which there may be a fibrous capsule.

Lobar Contagious Pneumonia and Septic Pneumonia. Contagious pneumonia may be distinguished from ordinary pneumonia by the fact that in the latter the alterations in the lungs are all at the same stage, and in no other form of pulmonary inflammation is the distension of the interlobular septa so marked as in contagious pneumonia. There is, however, one condition in cattle which somewhat resembles it, namely, a form of septic pneumonia occurring in cows in which there is also a certain amount of marbling, but not to the same extent as in the contagious disease. Moreover, in this country contagious pleuro-pneumonia is at present practically non-existent, and any appearance which is suggestive of the

FIG. 3.—LUNGS OF SHEEP. VERMINOUS NODULES
a. Small. *b*. Larger nodules.

FIG. 4.—VERMINOUS BRONCHITIS IN CALF
Note longitudinal section of bronchus filled with parasites, *Strongylus micrurus*. (Preparation by S. Delépine.)

disease, in the absence of any known infected areas, will probably be found to be of the nature of this septic pneumonia. This latter condition, too, is of a more acute character and renders the lungs almost putrid.

Judgment in Pleuro-pneumonia and other **Pneumonias.** The meat inspector is advised to seize and condemn the flesh of these carcases unless the lesions are very slight in extent and no emaciation whatever is present, and further, unless the carcase sets perfectly well and with an absolutely normal appearance. In some cases it may be advisable to condemn the fore-quarter or quarters and pass the hind-quarters. It seems to be established that the meat of animals affected with pleuro-pneu-

Fig. 5.—Lung of Sheep

Cross-section showing the presence of verminous nodules, with which the lung is riddled. Large calcified nodules occur at the apex. This case is one of a number which suffered similarly in an outbreak in a valley in Wales. Many had bronchitis and some died. Around the nematode were patches of broncho-pneumonia. (Professor Leith's Collection.)

monia can be eaten without ill effects. But if the animals are killed when feverish or if there be emaciation with dropsy present, the carcase should be condemned.

Pneumonia, either of the lobar or lobular type, is often present in the lungs of pigs suffering from swine fever, in which case it is probably due to an organism other than the swine fever bacillus. The judgment of the inspector in such cases is determined by the presence of swine fever itself, and not by the condition of the lungs.

VERMINOUS PNEUMONIA

Several parasites belonging to the worms occur in sheep, cattle, and swine, producing first of all considerable bronchitis; and following upon this an inflammation of the pulmonary tissue itself of the lobular type, thus sheep are attacked by *Strongylus filaria*, young cattle by *Strongylus micrurus*, and pigs by *Strongylus paradoxus*.

The judgment of the meat inspector in all cases of verminous pneumonia will be to seize and condemn the *infected lungs* and to examine the carcases themselves for emaciation and any dropsical effusions in the body.

If these latter are present the carcase should be condemned.

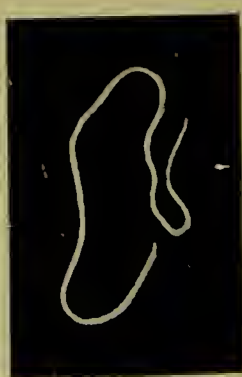


Fig. 6.—Lung-worm of Pig
Natural size.

Other Pulmonary Parasitic Conditions. Other parasites may be present in the lungs in one or other stage of their development, giving rise either to cysts such as those of the hydatid type, and the liver-fluke may also find its way into the pulmonary tissue. Such parasitic invasion causes the consolidation of the lung tissue around it and will cause the inspector to seize the infected lungs, the condition

Fig. 7.—Verminous Bronchitis in Calf
Note the large bronchus full of the worms, *Strongylus micrurus*. (Preparation by S. Delépine.)

of the carcase, however, will be determined by the examination of other parts.

Parasites in Lungs. These may be summarised thus :

Strongylus micrurus in cattle.
,, *filaria* in sheep.
,, *paradoxus* in swine.
,, *capillaris* in sheep.
,, *apericus* in sheep.
,, *rufescens* in sheep.

FIG. 8.—A PORTION OF A BOVINE LUNG WITH LARGE CYSTS PROTRUDING FROM SURFACE
Hydatid (Leighton).

T. echinococcus cysts in most animals.
Distomum hepaticum in sheep and cattle.
Larvæ of *Pentastomum.*
Cysticercus tenuicollis.
,, *bovis.*
,, *cellulosæ.*

Fungoid Conditions. Fungi, or moulds, produce local patches of inflammation in the lungs, especially in birds, but also in cattle, the lesions taking the form of hepatised areas with a somewhat marbled appearance. Inside the nodule may be the mycelia and spores of the fungi. The most common mould to act in this way is *Aspergillus.* The disease being purely local, the lungs only require seizure.

Tumours of Lung. Occasionally tumours occur in the lung, these usually being either adenoma, chondroma, or sarcoma, necessitating seizure of the organs themselves and examination of other parts of the body for similar growths.

Actinomycosis occurs occasionally, as does botriomycosis, producing nodules varying immensely in size and occasionally becoming very large. Such occurrences are usually part of an infection which attacks other parts of the body as well.

Pseudo-tuberculosis. This is a term which we should be glad to see banished from the vocabulary of pathological literature. It is both useless for descriptive purposes and misleading as an ætiological term, and since it is used to include a great variety of morbid conditions arising from many different causes, the sooner it is discarded the better. At

any rate there is no justification for applying the term *pseudo-tuberculosis* to conditions whose ætiology is perfectly well known to be non-tubercular ; and, if used at all, it should be restricted to such conditions of whose nature we are still ignorant.

In this country the term *pseudo-tuberculosis* is almost entirely applied to that condition of the lungs of sheep caused by the presence of a verminous parasite, *Strongylus rufescens*. The lesions resulting from this are those due to its irritative presence, and are therefore of an inflammatory nature. The condition should therefore be called *verminous pneumonia*, and our description of it will be found under that heading (*see* p. 990). Other conditions less frequently encountered in our own slaughterhouses than in those abroad, and known as *pseudo-tuberculosis*, are bacterial in origin but not due to the *tubercle bacillus*. Until the nomenclature has been adjusted more satisfactorily, they must still be referred to under this name.

These conditions of bacterial pseudo-tuberculosis, which are really, in the opinion of the writer, to be regarded as diverse forms of bacterial necrosis, may be summarised as follows :

(1) Epizootic pseudo-tuberculosis of the sheep (occurring especially in Australia and America).

(2) Bacterial caseous pneumonia of cattle.

Fig. 9.—Lung of Cow

Interstitial emphysema in a cow in a case of extensive lymphosarcomata affecting diaphragm, lung and pleura. Mistaken for tuberculosis. (Preparation by S. Delépine.)

(3) Pleural nodules in cattle.

(4) Calcified granules of kidney in sheep.

(5) Pseudo-tuberculosis (*tuberculose zoogloeique*) of hares, rabbits, sheep, cattle, birds.

Lesions produced. In all these forms of the condition the one common lesion is the occurrence of a necrotic process resembling caseation, and hence suggestive of tuberculosis. The tissue, however, does not, as a rule, contain giant cells, and in its later stages is differentiated from true tuberculosis by the fact that the caseated area does not calcify but dries up in a laminated manner. The lesions may occur chiefly in the glands, especially in the epizootic form, whilst in other cases there are numbers of disseminated areas like abscesses, showing a caseous, necrotic, whitish centre. These may be found in any organ.

Man is susceptible to infection from these bacterial necrotic conditions, and it is therefore the duty of the meat inspector to seize and condemn any organs showing these necrotic or caseous patches.

Bacteriology of Pseudo-tuberculosis. Various groups of microbes have been demonstrated as the causal agents in these conditions, including *micrococci, bacilli, cladothricidæ,* and *fungi.* In the caseous pneumonia of cattle, Kitt described bacilli 1.5 m. long, staining by Gram's method. In the fairly common condition of rabbits Pfeiffer described a bacillus, as did Malassez and Vignal in chickens, and Preiz and Guinard in sheep. This latter may be the organism of the epizootic form also described by Cherry and Bull. In this disease the sheep showed caseous changes in all the principal groups of glands (bronchial, mediastinal, portal, prescapular, kneefold, and intermuscular). Valle has also described a short bacillus from calves, in which the lesions were confined to the liver in the form of small white nodules.

The appearance in gelatine culture of the pseudo-tuberculosis bacillus is shown in Plate XXXI., as well as the microscopic appearance.

From what has been said, it will readily be recognised that many of the necrotic and caseous conditions which inspectors meet with and pass over with no further notice than simply seizing the organ, and an accompanying mental query as to their possible tubercular nature, are really due to one or other of the organisms noted above. Most inspectors are familiar with these appearances in a general way, and in the absence of any further knowledge put them down to tuberculosis or parasites.

Pseudo-tuberculosis in Sheep. Another condition which is described under this name is also called Lympho-adenitis, the latter name suggested by the caseous condition of the lymphatic glands. The disease seems to be extremely rare in Great Britain, and the writer has seen one case only at the Edinburgh abattoir. It is common in some parts of the world, however, being reported as epizootic in some parts of Australasia and America, and as one of the commonest causes of the condemnation of carcases in the export abattoirs of New Zealand.

The lesions are those of localised inflammation followed by a suppu-

ration with nodule formation, a capsule surrounding the nodules. The contents of this suppurating nodule are greenish in colour, purulent, varying in consistency and drying up into a stratified or lamellar arrangement. There is no calcification as in true tuberculosis. The nodules may be distinguished from old hydatid cysts by the fact that the latter can easily be enucleated, showing the cyst-wall left behind ; moreover, hydatid cysts are greyish in colour and often calcified. A New Zealand inspector thus describes the appearance :

"The most common seat in the carcase proper is undoubtedly the lymphatic glands, particularly those of the precrural, prescapular, and popliteal regions ; but the various other glands may be affected, either primarily or secondarily. In no case, however, so far as I can ascertain, have the pharyngeal, parotid, or sublingual lymph-glands been found affected. Nodules possessing all the characteristics have been found in other portions of the carcase proper, such as the udder, the intermuscular tissue, &c., in one instance which came under my own observation an abscess the size of a bean being situated in the centre of a 'chop.'"

Viscera. "For a considerable time I was of opinion that this was a disease practically confined to the lymphatic glands, but experiments have proved that the condition variously described in reports as 'septic pneumonia,' 'septic pleurisy,' 'suppurative pleuro-pneumonia,' &c., is the same disease, due to exactly the same micro-organism. So far I have no evidence that the disease ever affects to any great extent other organs, such as the spleen, liver, kidneys, and intestines, though it may be that further observations will lead to a different conclusion."

Post-mortem Appearances. "So far as we are aware the disease when contracted naturally is never fatal, at most in long-standing cases a condition of cachexia resulting. The only evidence regarding the general distribution of the lesions we have is obtained from animals killed for human consumption, particularly at the meat export slaughter-houses."

The following description from another colonial writer (Mr. Edgar) approximates more nearly to the case observed by the present writer :

Caseous Nodules in Sheep. "The most frequent cause of the condemnation of the carcases of sheep is the presence of suppurating foci in the internal organs and the carcase. These lesions are most commonly found in the lung and pleura, but may also be present in other parts of the viscera and in the lymphatic glands and muscles of the body, the most common site being the lymphatic glands of the groin, the muscles of the thigh, and the substance of the mammary gland.

"The lesion takes the form of an abscess or caseous tumour enclosed in fibrous capsule, the contents of which consist of pus, creamy in consistency and of a pale green colour. Later, by pressure and absorption of its liquid parts, the pus becomes caseated, and the parts may heal. The lungs may contain one or more of these abscesses or nodules, and it has been my experience to find them always isolated, the intervening portions of the lung being in most cases healthy.

"When situated in the costal pleura they are less likely to become caseous or to heal, and there is more pus. In recent cases the pleura is brightly inflamed ; in older ones it is thickened and attached to the lung by fibrous adhesions. Sometimes the abscess involves the costal muscles and appears as a small bulging tumour between two ribs. The presence of these abscesses is usually confined to one portion of the body—most commonly the lungs and pleura—but it is by no means rare to find the muscles of the thigh or the lymphatic glands involved at the same time."

Commenting upon these and other reports of the disease, the editor of the *Magazine of the Department of Agriculture for New Zealand* says :

"Other veterinarians who have experience in inspections, and have had opportunity of comparing its prevalence in different breeds, agree that the disease is much more prevalent in the Merino than in others."

Pathology. "The lesion commences by the arrest of the specific bacillus, generally in a lymph-gland where one or more are surrounded by and included within the phagocytes. The micro-organisms multiply within the cells, and ultimately cause the degeneration and death of the latter. Simultaneously a slow chronic inflammation occurs around the focus of attack : there is proliferation of connective-tissue cells and the formation of more or less new fibrous tissue. As the process spreads outwards the centre degenerates, and the protecting wall increases in thickness. In fact, all the phenomena of the pathology of true tuberculosis in a gland occur, with the exception of the formation of giant cells. The degenerated centre of the nodule assumes a greenish tint, especially distinct at the time of exposure by the knife, but gradually becoming greyer afterwards In older tumours in the centre of the purulent or caseous mass (for the consistency varies from that of cream to that of cheese in different tumours) there are usually present no bacilli which can be demonstrated by the microscope or by cultural methods.

"The pulmonary lesions I have not had much opportunity of observing in the earlier stages. As to whether the primary lesion is ever in the lung or the pleura, definite information is wanting ; but it will be observed that my feeding experiment in the sheep had a negative result, while Norgaard and Mohler were equally unsuccessful with their feeding experiments. In addition, the question as to whether the pleurisy is secondary always (most of my evidence tending to this conclusion), or whether it may occasionally be primary to the lung affection, remains to be settled. Generally, however, the first nodules appear near the pleura, most frequently in the supero-external region. I have personally observed them as small as a millet-seed, readily overlooked and possessing a slightly greenish tint, even through the intervening pleura. Gradually the pleura becomes involved, a fibrinous exudate results, and later on, provided practical recovery with a slight permanent adhesion does not result, a quantity of pus or caseous material develops in the pleural cavity, localised always more or less by a thick fibrous wall."

Stomach Contents in the Lungs. One of the points in the inspection of the lungs to which the attention of the meat inspector should always

be directed, and which is too often overlooked, is the examination of those organs to determine whether or not any of the *contents of the stomach* have passed into the tubes during the process of slaughtering. This frequently happens by means of the violent inspirations of the animal, the contents of the stomach passing first of all into the pharynx and thence being drawn in the act of inspiration in the trachea and the bronchi. This is a common thing in the lungs of cattle, and is often helped by the pressure applied to the abdomen by the slaughterer, who intends thereby to assist in the bleeding of the animal. Especially common is it in cattle which are slaughtered by the Jewish method, in which both the œsophagus and trachea are divided at the same moment. In order to determine the presence or absence of the contents of the stomach in the lungs, the inspector should make a cross-section of those organs below the bifurcation of the trachea. Should the stomach contents be found to be present, there should be no hesitation in seizing the lungs, as they are extremely unfit for food in this condition.

Just as stomach contents may be drawn into the lungs, so may blood itself, again most frequently in cattle killed by Jewish method. Such lungs ought to be seized and condemned, as in the case of lungs with stomach contents, and the reason in both cases is the same, namely, that such lungs decompose much more readily than normal lungs.

The Pleura. Apart from the conditions of tuberculosis and the inflammatory processes which occur in the lung, the pleura itself will but rarely call for the attention of the inspector. Occasionally, however, there may be a simple pleurisy without pneumonia following upon a fracture of the rib, or from a foreign body which is penetrated into the chest from the stomach. The judgment of the meat inspector in such cases will be determined by general considerations as to whether the injury has produced a septic condition or not, and there will rarely be any difficulty presented in coming to a decision as to the disposal of the carcase for food or otherwise.

Abscess in the Lungs and Pleura. Areas of suppuration occurring in the thorax may be the result of a general condition of pyæmia, from the bursting of an abscess in the throat and the discharge of its contents into the bronchi, or as the result of a foreign body penetrating the lungs from the second stomach in cattle, this latter occurrence being fairly common. In sheep, abscesses are occasionally found as the result of parasitic infection. In all cases of abscess in the thorax the lungs themselves should be seized, together with such parts of the carcase as are obviously unfit for food, but whether the whole carcase is to be condemned or not will depend upon whether the disease is local or general, and the results which have followed from it.

Finally, in connection with the lungs it should be remembered that there are quite a large number of pathological processes which produce nodules somewhat like those found in tuberculosis, and which also undergo necrosis in the form of caseation. If a bacteriological examination be made of these false tubercles they will be found to contain various kinds

of organisms, such as micrococci, bacilli, cladothrices, or fungi, but not the tubercle bacillus itself. Such nodules occur particularly amongst the food animals in rabbits, cattle, and sheep, especially in the last, in which disease a specific bacillus has been described and which is known as the bacillus of pseudo-tuberculosis (*see* later). This condition is differentiated from true tubercle by the absence of giant cells and by the fact that its necrotic portions do not calcify but become dried up. As regards the judgment of the meat inspector in such cases, it will be sufficient to say that in all cases where the lungs are thus affected the inspector should exclude them from sale.

THE HEART

The morbid conditions of the heart and its membranes which call for the attention of the meat inspector are practically limited to the various inflammations which attack the organ, the presence of tuberculosis, the occurrence of parasitic cysts, and the presence of small hæmorrhages in the membranes. Of these, perhaps, the most frequent to be encountered is the traumatic pericarditis of cattle.

Traumatic Pericarditis. This is by far the most common disease of the heart in cattle, with the possible exception of tuberculosis affecting the pericardium. Its frequency is due to the anatomical relationship of the second stomach and the pericardium, which are only separated from each other by the diaphragm. This explains how it happens that foreign bodies, such as nails and other sharp substances, so commonly penetrate into the heart membranes from the stomach.

It is but rarely that the early stages of this condition are seen, and by the time the inspector examines the heart there is usually present a copious exudation in the pericardium which varies in consistency from a thin serous fluid to almost solid deposit, causing adhesions of the pericardium to the heart and considerable hypertrophy of the organ itself. The exudate in the pericardium varies immensely in colour and in consistence, being either serous, fibrous, purulent, blood-stained or yellowish green. Not uncommonly it is quite putrid owing to the decomposition which has followed from the entrance of organisms along the track of the wound from the stomach. Thus the pericardial contents may have a foul, putrid odour. In the absence of such processes, there is no smell. The amount of the exudate is sometimes enormous, quantities of from two to three gallons occurring ; and when such is the case it, of course, follows that there is an immense distention of the pericardium. When the exudate has become organised, it produces a thick layer of yellow deposit with a rough surface, making the heart appear greatly enlarged, and the membrane itself will have the consistence almost of leather, enveloping the whole organ in a very rigid case. From the rough warty appearance caused by this exudate the term *cor villosum* has been applied to this condition. The muscle of the heart itself in such a case is frequently degenerated and softened, and may contain abscesses in its substance. The actual foreign substance which was in the first place

responsible for the condition may be found either in the muscle, in the pericardium, or even in one of the ventricles. Frequently it cannot be

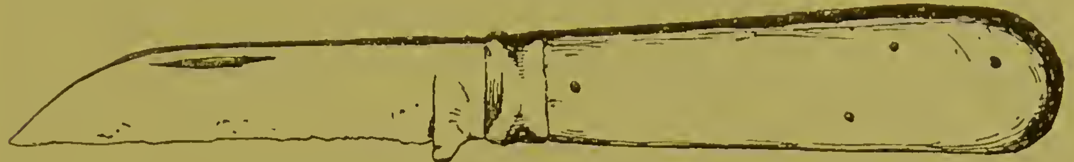


Fig. 10.—Foreign Bodies in Heart

The pocket-knife shown in the accompanying drawing was found by Mr. Snowball, Director of the Dunedin Abattoir, in the thoracic cavity of a bullock slaughtered for human consumption. Mr. Snowball states that the knife (opened, as seen in the drawing) was found lying partially within the thoracic cavity, in about the median line, its point having pierced the pericardium and just come in contact with the heart-wall. Cases of elongated and more or less pointed foreign bodies, such as nails, pieces of wire, needles, &c., passing from the rumen to the heart, are common enough among cattle ; but the presence of so large an object as this is a somewhat unusual experience. Settlers would do well to bear in mind the possibility of foreign bodies being present in this position, in cases of sickness or death among cattle in which the cause appears obscure. The symptoms are usually those of intermittent or chronic indigestion, followed by emaciation, weakness, distension of the jugular veins, œdema of the subcutaneous tissues beneath the jaw and sometimes extending right down the neck to the dew-lap. Death is the ultimate result, the foreign body in time piercing the heart. (By permission of New Zealand Government.)

discovered at all. Should the condition last long enough adhesions to the surrounding organs are invariably produced, so that the pleura, the pericardium and the diaphragm all become involved.

Judgment in Traumatic Pericarditis. The judgment of the meat inspector, with reference to the carcase in cases of traumatic pericarditis, must be determined by the following facts. No case of disease, as far as we are aware, is recorded as the result of eating meat from cattle suffering in this way ; neither is there any case of human beings suffering from the effects of eating decomposing meat in which traumatic pericarditis has been assigned as the cause. Even where the exudate has been of a putrid type, there seems to be some doubt as to any ill effects following the consumption of the meat, though careful attention must be paid to the condition of the muscles by the inspector. It need hardly be said that the heart itself and the surrounding organs should be seized and destroyed, and as regards the rest of the carcase the general principles which guide the inspector in his judgment of meat must be employed. If it be asked how it is that these cases of septic pericarditis can exist alongside meat which is apparently healthy, the answer is probably to be found in the observation of the clinical symptoms which are present in such cases. It is a curious fact that cattle suffering from traumatic pericarditis usually show no signs of fever during life or even when they are slaughtered. On account of the condition being localised, the liver and the kidneys, as well as the heart and the ordinary muscles, do not show the usual fatty degenerations associated with septic conditions. When death ensues naturally it is due, not to the toxic condition which might be supposed to be present, but by the mechanical interference with the action of the heart which results either from the foreign body itself or by the immense amount of exudate produced. The disease seems

to occupy a position peculiar to itself, and had we in Great Britain the continental institution of the Freibank there eould be no hesitation in utilising the earcase of sueh eases for sale as inferior food. In the absenee of sueh an institution the inspeetor must base his judgment upon the presence or absence of dropsy in the flesh, upon the presenee or absenee of degenerations in the kidney and liver, and on the degree of putrefaction present, if any.

Traumatic pericarditis of eattle is perhaps the only septic condition of any extent in whieh the meat inspector need have any doubt of the case requiring condemnation.

Endocarditis. Inflammation of the endoeardium oeeurs in eattle and pigs especially, and may be associated with rheumatic eonditions in eattle, with septic diseases, and with swine fever or swine erysipelas. The disease is eharaeterised espeeially by rough thiekenings oeeurring

FIG. 11.—ANTERIOR PART OF LEFT VENTRICLE AND AURICLE OF HEART OF PIG (SECTION)
Cysticercus cellulosæ. (Preparation by S. Delépine.)

upon the heart-valves, which may later degenerate into ulcers. From these valves thrombosis and embolism readily occur, giving rise to the presence of infarcts in the liver, lungs, spleen, and kidneys. Since various bacteria are associated with the vegetations on the valves, the heart in such cases should be seized and condemned (Plate VI.).

FIG. 12.—HEART OF A COW

Frontal sections seen from the back, including the lungs, and at the root of the heart, and a transverse section of the trachea. Old tuberculous pericarditis. Tubercle bacilli present, specially around large vessels. (Preparation by S. Delépine.)

Parasitic Affections. Three parasites may be found in the muscle of the heart in their cystic stages. These are the *Cysticercus bovis* in cattle, the *Cysticercus cellulosæ* in swine and sheep, and hydatid cysts. The two former occur especially underneath the epicardium or underneath the endocardium, occasionally, however, being found within the heart-muscle itself (Fig. 11). The hydatids or echinococcus cysts are found within the muscle. In all cases of parasitic affections of the heart and its membranes the organ should be seized and condemned.

Tuberculosis. One of the most striking contrasts between the pathology of bovine and human tuberculosis is to be found in connection with the pericardium. In human beings it is a pathological curiosity to find tuberculosis attacking the membranes of the heart, while in cattle tubercular pericarditis is found in a large proportion of cases in advanced general tuberculosis. The appearances presented are precisely similar to those of tuberculosis in other serous membranes, and since the condition is always associated with the disease in other parts it requires no special consideration of itself.

Rupture of the Heart. This accident occasionally occurs as the result of external injury or following upon a weakening of the heart-muscle as the result of degenerations or parasites. The degenerations which may produce it are probably the advanced fatty degeneration, and the parasitic condition most commonly responsible for rupture is the hydatid cyst.

Hæmorrhages. The attention of the meat inspector will frequently be directed to the presence of numerous petechial hæmorrhages which appear in the epicardium or endocardium and which deserve careful notice on his part. Such hæmorrhages here, as elsewhere, indicate the

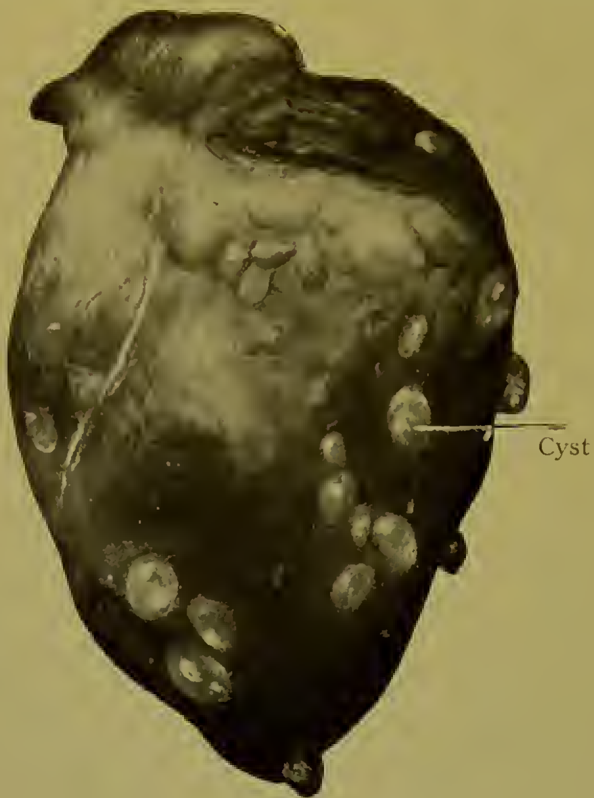


Fig. 13.—Heart of Pig
Cysts of *Cysticercus cellulosæ.*

fact that the smaller blood-vessels, and especially the capillaries, have undergone a degeneration of their walls here and there, thus allowing of the escape of minute quantities of blood. This degeneration is associated especially with various forms of bacterial poisonings, and in fact is almost pathognomonic of infectious fevers. It should cause the inspector to suspect at once some bacterial septicæmia, such as anthrax or fowl cholera or other organismal disease. Whenever such hæmorrhages are observed in the epicardium the inspector should turn his attention also to the liver, where he will probably find areas of focal necrosis or patches of degeneration indicating the presence of toxic substances in the system. Any carcase showing this phenomenon present should be carefully observed as to the condition of its muscles and its setting before being passed as fit for food.

Tumours. It is but rarely that tumours are found affecting the cardiac apparatus, when they do occur being usually in the nature of fibromata or sarcomata. The former are generally chronic inflammatory thickenings, and the latter secondary growths from some other part of the body. The writer has seen one case of multiple melanotic sarcomata in the heart in a case where there were great numbers of these tumours in all the organs.

Simple Pericarditis. Inflammation of the pericardium other than that associated with other wounds or tuberculosis is generally of rheumatic origin or a spread of the inflammatory process from the pleura. It presents the usual appearances of inflammation of serous membranes, and calls for no special comment.

CHAPTER XV

DISEASES OF THE LIVER, KIDNEY, AND SPLEEN

Of all the internal organs which are used for purposes of food, there is, perhaps, none which is so frequently condemned by the meat inspector as is the liver. This is not in the least to be wondered at when one thinks of the functions which this organ has to perform and of its connections with the alimentary tract. The liver is practically, at any rate from one point of view, the cesspool of the body. Moreover, its cells are of a highly specialised nature and thus very readily become devitalised. Any injurious matters which are in the circulation, such as all bacterial toxins and chemical agents, as well as a number of parasites, all find their way, sooner or later, into one or other part of the liver, and hence it is no wonder that this organ is so frequently found to be affected with some form or other of morbid process. Inasmuch as it is always sold for food, unless condemned, it is of great importance that *every liver in the slaughterhouse should come under the notice of the meat inspector.*

We may take up in turn the various conditions which affect this organ and which are most commonly found in this country.

DEGENERATIONS

Under this heading we may consider fatty degenerations, cloudy swelling, fatty infiltration and waxy degeneration.

The first two have an intimate connection with each other, inasmuch as cloudy swelling is the first change which takes place in the liver cells (as in other highly specialised cells) under all conditions of inflammation or wherever there are chemical or bacterial toxins acting upon the cells. It is a microscopic appearance, in which the liver cells become swollen and granular, with the nucleus indistinct, and which is followed (unless the cause be removed) by fatty degeneration itself. The condition of cloudy swelling, therefore, as well as that of fatty degeneration, should always attract the attention of the inspector, because these may be the most obvious signs, and indeed the only signs, of the presence of toxins in the body which may be of serious importance. In any case where a liver is found to be fatty, a careful examination of the whole carcase should be made with a view to ascertaining its fitness for consumption (*see* Plate XXI.).

The Fatty Liver. Fatty degeneration, either as a sequel of cloudy swelling or as a direct change, is characterised by the yellowish brown

colour of the liver substance, by its soft substance, and by its greasiness on section. If the knife be scraped over the surface of a cross-section it will be found that fat globules are readily scraped off. The liver tissue is very friable, breaking up easily between the fingers. If a small portion of the liver, such as a very thin slice cut off with a knife, be placed in osmic acid in a vessel, it will turn black in a very few minutes, the blackness being due to the presence of the fat, which is thus stained. The liver itself is not enlarged in fatty degeneration, because the morbid process consists in the breaking up of the cell protoplasm itself, resulting in a soft flabby condition, in which the edges of the organ remain sharp and are not rounded. If the liver cell in this condition be placed under the microscope it will be found to contain a large number of small fat globules, these being of varying sizes and sooner or later running together into larger ones.

Fatty Infiltration. In this condition the distribution of the fat in the liver is not so uniform as in the case of a degeneration affecting the whole organ, but is frequently confined to the outer zone of each liver lobule, this being especially the case in the early stages of the infiltration. To the naked eye this condition is marked by a yellowish colour in the peripheral portion of each zone lobule, and should the central part of the lobule remain normal the contrast in the two colours of the fatty part and the healthy part is readily seen. To the naked eye the organ itself presents the same colour as does the liver in the state of fatty degeneration, for the simple reason that in both cases the colour is determined by the presence of fat. It is, therefore, yellow or yellowish brown. Otherwise, however, the characteristics are different, for in this condition the organ is enlarged and its margins rounded, its consistence being, not nearly so flabby as that of degeneration. These facts are simply due to the difference in the source of the fat in each case. In fatty infiltration this comes from without. It is brought to the liver in excess and is stored up in the liver cells, which it therefore causes to be enlarged, the fat being the additional element. It is therefore obvious that the greater the infiltration the larger the liver and the more rounded the margins. The degeneration, on the other hand, is a breaking down of the liver substance, which therefore tends to reduce both its consistency and size. Under the microscope liver cells in fatty infiltration exhibit the presence of a varying number of globules of fat, usually from three or four up to ten, some of which are very large when compared with those in the degenerated cells. The nucleus in infiltration is sometimes pushed to one side or even into a corner.

The amount of water present in the organ is considerably less than normal in the infiltration and the specific gravity also comparatively less.

It should be remembered that if an advanced condition of fatty infiltration persists for a considerable time it interferes with the integrity of the liver cells, which often commence to degenerate, so that the two conditions of fatty infiltration and the fatty degeneration may, and often are, present at one and the same time.

Waxy Degeneration. This morbid change, which is so constantly associated in human beings with the presence of tuberculosis, is comparatively rare in the domestic animals, with the single exception of poultry. In fowls suffering from this condition the liver is found to be yellowish red in colour and friable. Odd cases have been recorded as occurring in cattle, but the disease is so rare as to be unimportant in them. When it does occur the organ is enlarged, of a firm consistence, and of a dull greyish colour. It has been observed in pheasants.

From what is known of waxy degeneration in human beings it is probable that its cause is to be found in the effect of bacterial toxins upon albuminous matter, causing a deposit of the waxy material in the delicate connective-tissue fibres almost throughout the body.

NECROSIS

Various forms of necrosis are found occurring in the liver, most of them being associated with the presence of bacteria or their toxins, while others are due to emboli which result in the formation of *infarcts.* But in addition to these conditions, in which a definite localised portion of liver tissue undergoes absolute death, rendering it pale and yellow to the naked eye, there is another very common change of a necrotic nature frequently to be observed on a cross-section of the liver. This is the condition of so-called *focal necrosis.*

Focal Necrosis. This gives the appearance of small, rounded, dark-coloured areas, usually of the size of a threepenny piece, or a little larger, scattered irregularly throughout the whole organ. These areas of focal necrosis are due to the presence of various forms of toxins which are in course of elimination in the liver, but which, nevertheless, set up this local change, which differs from necrotic areas in that it is *congested* with blood, instead of being anæmic. It may be frequently seen in septic conditions, and when present should always cause a careful examination of the meat.

Infarcts. Ordinary infarcts are of no great importance from the point of view of the meat inspector. They appear as yellowish patches commonly, immediately under the capsule of the liver, most of them being wedge-shaped with the base of the wedge to the surface.

They are due to obstruction of a small vessel in that area, thus cutting off the blood-supply to the part, which therefore dies and ultimately dries up.

Bacterial Necrosis. This form of local necrosis is found in the liver in cattle, pigs, and sheep, and is due to a special organism termed the bacillus of necrosis. The condition cannot be called common in this country, not more than five or six cases a year being detected in the slaughterhouse at Edinburgh. The appearance is very typical and can hardly be mistaken for anything else (*see* Plate XXVII.). The necrotic areas are disseminated throughout the organ and vary in size from that of a sixpence to that of a shilling, being as a rule rounded, firm, sharply defined,

yellow in colour, surrounded by a reddish peripheral zone. It is worthy of note that in this condition the liver itself is frequently enormously enlarged, it being not uncommon to find the organ three, four, or five times its normal size. The liver tissue between the necrotic areas is occasionally quite normal, but more usually is pale yellowish or greenish yellow in colour, being either fat or stained with bile. If the condition has lasted long enough the area of necrosis becomes surrounded with a fibrous capsule within which the necrosed tissue becomes softened into what looks like a greenish pus which has an acid reaction.

Judgment in Bacterial Necrosis. In the judgment of most meat inpectors it is sufficient if the liver itself be seized and condemned in a case of bacterial necrosis, the carcase being considered as fit for human consumption. This opinion is based upon the fact that there is nothing else to be found beyond these well-defined local areas of necrotic tissue in the liver. At the same time it should be remembered that at one stage of this disease there is a decidedly feverish condition in which the carcase can hardly be regarded as sound. Moreover, there are cases in which there is a very considerable amount of jaundice present as the result of the liver condition. It may be mentioned that the bacilli are found in numbers together just at that portion of the liver where the margin of the necrotic tissue merges into the healthy liver around it.

It may also be mentioned in passing that in addition to the forms of necrosis already described numerous similar areas may be found in the liver in swine fever.

Cirrhosis of the Liver. This condition of the liver, which is produced by an overgrowth of the connective tissue of the organ, occurs in cattle, sheep, and pigs from causes which are not very definitely known, as well as from the presence of the liver-fluke. In cattle, where the disease takes various forms, it is probable that the irritating material which is the causal agent is to be found in toxic matters or bacterial toxins, which are either produced in the intestines or absorbed thence. The nodular form of the condition is not so usually found in animals as it is in human beings, although very well-marked cases occur every now and then. The liver itself is either enlarged or smaller according to the stage in which the process is; thus in the early stage when the most active growth of new connective tissue is taking place the liver may be larger than normal, while, later on, when the connective tissue has reached the stage at which it begins to contract (as all connective tissue does sooner or later) the liver becomes shrunken, hard, and firm, and somewhat distorted in shape. Corresponding to these stages are changes in the colour, that of the early stage being somewhat mottled, later on becoming yellowish, and finally pale.

On cutting across the organ with a knife the firm, hard, connective tissue is very obvious and may be readily seen as a network of large meshes, consisting of the newly formed connective tissue, within which is the liver tissue proper, which is either congested or later on pale, from

the fatty degeneration and atrophy. Associated with this disease is a chronic venous congestion of the veins of the portal system, which are compressed by the contraction of the connective tissue. This leads in its turn to a chronic catarrh of the stomach and bowels and finally to a dropsical condition of the abdomen.

Owing to the peculiar arrangement of the connective tissue in the liver of the pig the enlarged cirrhotic liver occurs frequently in those animals, to such an extent that the liver reaches two or three times its usual size and is of an extremely firm consistence.

In human beings this cirrhotic liver is frequently associated with chronic indulgence of alcohol, and it is suspected that in the case of cirrhosis of the liver in swine (the food that they are frequently fed upon being food-stuffs from breweries), this may have an important bearing upon the condition.

FIG. 1.—LIVER OF COW
Medium size, uniformly distributed, discrete tubercles (tubercle bacillus found). (Preparation by S. Delépine.)

Judgment of Cirrhotic Liver. As regards the judgment of livers in a condition of cirrhosis, it may be said that a slight amount of connective-tissue formation need not involve the seizure of the organ, while, on the other hand, if the condition has advanced to such an extent that the liver has quite lost its usual consistence, it should then be seized and condemned.

CAPILLARY ANGIOMATOSIS

A very peculiar form of liver disease found extremely commonly in some places on the Continent, but to which attention is but seldom directed in Great Britain, is that known as *capillary angiomatosis*. In this condition the liver, which is not otherwise altered, shows upon the surface as well as upon cross-section a considerable number of purplish areas scattered irregularly throughout its whole substance. The areas are mostly of the size of a threepenny piece or a little larger. On cross-section they are found to be composed of a network, in the interstices of which lies blood. The structure of the network itself is that of a wall of connective tissue which is lined by endothelium, a structure which is

FIG. 2.—AVIAN TUBERCULOSIS
Liver of a Fowl showing Tubercular Nodules. (Professor Leith's Collection.)

therefore comparable to that of large capillaries. From this fact the condition is regarded as a formation which is due to arrested development, the capillary network not being sufficiently constructed, and the columns of liver-cells failing to grow in their supporting structures. Others regard these areas as partly hæmorrhages and partly as dilated blood-sinuses. A somewhat similar condition has been observed in female human livers after parturition, and from the fact that a considerable number of these cases in cattle come from cows it is possible that there is a relationship here involved. The view that the lesion is one of congenital non-development is strongly opposed by some authorities, which opposition is strengthened by the fact that it is not found in virgin heifers. Stockman regards the liver condition in this disease as the result of a distomatous cirrhosis followed by an enlargement of the capillaries of the liver, to which view, however, it may be objected that cases of capillary angiomatosis occur in the absence of cirrhosis. The present writer, who has observed this condition as occurring with great frequency in Sweden, is inclined to regard it as a *local degeneration of the vessels* in the area affected, probably of a *toxic nature.* Whatever the actual cause may be it is customary and probably advisable to withhold from sale all livers

which show this condition to be present. They should be seized and destroyed.

Tuberculosis of Liver. We have already dealt elsewhere fully with this disease and need only add here that it occurs in the liver in very varied forms. There may be merely a slight deposit upon the surface in the shape of coagulated lymph, which is a part of a general abdominal infection spreading by means of lymphatics. There may be nodules of very varied sizes, some of them extremely large, upon the surface of the liver, without any disease within the substance of the organ itself, such cases probably being later stages of the first mentioned.

Within the organ itself tuberculosis occurs in all stages, from that of miliary follicles to large caseating and calcified areas. Occasionally the lesion is circumscribed with a fibrous capsule, a form of disease which is *very apt to be mistaken for old hydatid cysts*, and *vice versa.*

In many cases of a doubtful appearance the condition of the portal gland may clear up the diagnosis.

Tuberculosis in Fowls. We have fully discussed in another part of this work (chap. xvi. Vol. III.) the relationship between mammalian and avian tuberculosis, and we need not refer further to that subject here, except to remind our readers that it has been shown that the avian bacillus is pathogenic for birds alone and not for mammals, and *vice versa*, that the mammalian bacillus does not usually show itself pathogenic for birds, though it can be made to do so by repeated experimental passage through animals.

The lesions in fowls in tuberculosis are usually very obvious, especially in the liver, where they are seen as large, irregular, or rounded areas, both on the surface of the organ and also distributed throughout it. Microscopically these lesions are said by Pfander to be poor in giant cells with peripheral nuclei. They caseate, as do other tubercular nodules, but in a more hyaline and less granular manner than one associates with mammalian tubercular caseation.

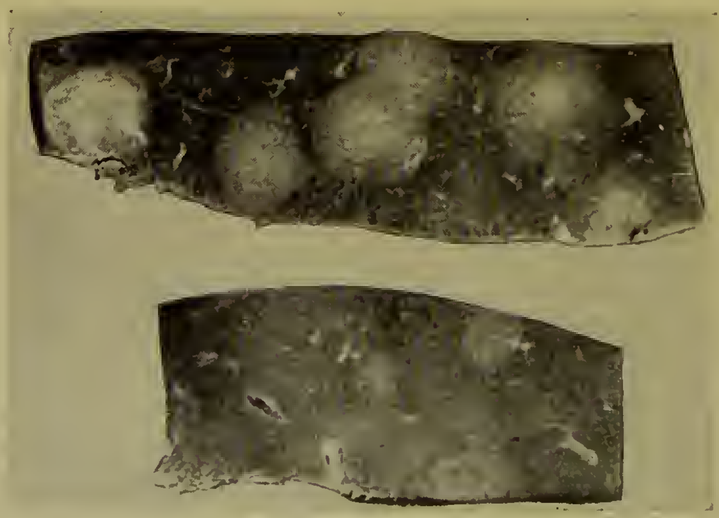


FIG. 3.—LIVER OF A YOUNG BULLOCK.
Bacterial Necrosis (*Streptothrix cuniculi* abundant.) Lesions had been mistaken for tuberculosis. (Preparation by S. Delépine.)

Fig. 4.—The Liver-Fluke (Distomum Hepaticum), Natural Size

The appearance of avian tuberculosis in the liver is known in some localities by the term "spotted liver," from the mottled appearance of the organ, by means of which attention is readily drawn to the condition. Fowls suffering from tubercle will frequently be emaciated and anæmic, the comb, skin, and visible mucous membranes being usually pale. In advanced disease the feathers are ruffled and the fowls often go lame from joint lesions. The inspector of poultry, however, can only be expected to recognise the disease when he has the liver, spleen, intestines, kidneys, or lungs available. The excellent photograph of tubercle in the liver of a fowl (Fig. 2) was supplied to the writer by Professor Leith.

PARASITIC CONDITIONS OF THE LIVER

Of the parasitic conditions in this organ the two which are most important in connection with meat inspection are that due to the infection of the liver-fluke and the presence of hydatid cysts.

Distomum Hepaticum. This, which is the largest as well as by far the commonest of the flukes, is a leaf-like trematode, the anterior end being conical and the posterior flattened. It possesses a firm, somewhat tough skin, to which are attached a number of spines, which play an important part in producing the irritation of the structures in which it comes in contact, and hence in causing the proliferation of connective tissue which is the most prominent result of the infection of the liver-fluke. The life-history has already been described (p. 928).

The parasite itself is found in the gall-bladder and the bile-ducts of the animals infected, the most common being cattle and sheep. Pigs and goats are also infected, and it has been found in the horse.

In some districts the pastures upon which the animals feed are so infected with the parasite in question that it is the rule rather than the exception to find evidence of it in the liver, and some writers go as far as to say that the majority of cattle contain either the flukes themselves or some evidence of their presence. As a matter of fact, different districts vary considerably in the relative frequency of occurrence.

Changes in the Liver in Fluke. The parasite on reaching the liver penetrates all over the organ, even into the smallest bile-ducts, where it may produce hæmorrhages and a certain amount of inflammation. In the early stages of the infection there is an additional secretion of bile from the irritative effects of the presence of the parasite, which has the secondary result of causing the animal (especially in the case of sheep) to fatten very rapidly. It is only in the later stages when the liver becomes hard and firm and atrophied as regards its proper cells that there is any clinical evidence of disease in the animal, this stage being characterised by the appearance of anæmia and (especially in the sheep again) dropsy.

In the case of cattle it is remarkable how little the nutrition of the animal is interfered with, notwithstanding the presence of large numbers of parasites, and even in those cases in which a well-marked cirrhotic condition of the liver has occurred.

It would appear that so long as there is a very small portion of the liver itself in which the gland-cells retain all their functional properties, that this is quite sufficient for the animal to keep in good condition. Ostertag states that he has never observed hydræmic cachexia in cattle as the results of the liver-fluke, even in very young animals, the only marked effects in them being emaciation.

Effects of Fluke on Sheep. It is, however, vastly different in the case of sheep, where by far the greatest proportion of the carcases in this species which are seized and condemned on account of their dropsical conditions are found to be badly infected with liver-fluke. Whole flocks which are pastured in the same locality may be found to be similarly affected, the number of sheep thus affected in England alone having been estimated at one million per annum. The condition is infrequent in swine, and apparently does not interfere with nutrition.

It should be remembered that the liver-flukes in the adult stages are obligatory parasites, their immature stages being passed partly as free-swimming embryos, and later in the body of a water-snail. Having destroyed this mollusc the larvæ attach themselves either to some water-plant or else to the stems of the herbage at the edges of the pond, where they become encysted. Here they remain and develop no further until the vegetable upon which they are is eaten by the sheep, cattle, or other animals in which the adult fluke develops. Even human beings, when they are the subject of liver-fluke disease, are infected in the same way through eating the plants upon which the parasite is encysted.

Distomum Lanceolatum. This second species of liver-fluke is of very much less importance than *Distomum hepaticum*, both on account of its greater rarity, and also because of its far less serious results when present. This latter fact is explained by the very much smaller size of the fluke, as it measures only about a third of an inch in length (being very much smaller than is commonly supposed and commonly represented).

It occurs in both sheep and cattle, but in neither is it common ; and its distribution is far more restricted to certain areas than is the case with *Distomum hepaticum*. Its presence is apt to escape the notice of the inspector because of the very slight results upon the liver itself. Thus the bile-ducts are not much enlarged and the liver tissue itself but little cirrhotic. Practically the only effect produced is a catarrhal change in the bile-ducts themselves.

Results of Fluke Infection. Contrary to what might be expected, it is not usual to find jaundice present ; because, although the bile-ducts become thickened to many times their normal size, their lumen is not actually occluded. Indeed, on making an incision into a thickened bile-

duct, the contents of it are well marked and quite characteristic. In the first place, the parasite itself may be present in small or great numbers, and, in the second place, there is an accumulation of waste products from the liver itself of a viscid consistence and greenish colour, together with calcareous matter, which when once seen can never again be mistaken. On the surface of the liver itself the immensely thickened bile-ducts may be seen running in the direction of the gall-bladder as thick whitish strands, having a radiating arrangement somewhat like the limbs of a star-fish (*see* Plate XXX.). The liver itself in certain parts, especially towards the free margins (Figs. 5 and 6), may be converted into a solid mass of fibrous tissue in which the ducts lie. On making an incision with the knife, the ducts' firm consistence is at once noticeable, and the calcareous contents of the bile-ducts give evidence of their presence by their grittiness. If

Fig. 5.—Bovine Liver, showing Results of Extensive Fluke Infection (Distomatosis)
Note the cirrhotic condition of the organ and the thick dilated bile-ducts. (Leighton.)

Fig. 6.—Liver of Sheep, badly affected with Fluke
Note that a portion of the organ has become entirely fibrous, and the whole very cirrhotic with thick bile-ducts. (Leighton.)

the gall-bladder itself be opened, immense numbers of flukes may be found in it ; in fact, it is not uncommon to find in a bad case as many as from five hundred upwards of the parasites in both bile-ducts and gall-bladder together.

Judgment in Fluke Livers. As regards the judgment of the inspector in dealing with livers infected with fluke, it must be remembered that there is no risk of conveying the actual disease to man, even though an infected liver be eaten. The only way in which man (in common with the animals) becomes a victim of fluke disease is by ingesting some vegetable upon which the fluke is encysted in the larval stage. The dual life-history must in all cases be completed, so that where the liver as an organ is in great demand for food there is *no occasion for undue severity* in seizing the organ ; in fact, there should be no possible objection in slight cases to cutting away that part of the liver which is most affected and allowing the rest to be sold, a practice which, as a matter of fact, is commonly adopted in continental countries.

Liver-fluke Lesions. The gross alterations caused by the liver-fluke in the tissues of the liver can be seen in the illustrations (Figs. 5 and 6),

which are photographs of an ox and sheep liver respectively, affected in this way. In the ox liver the very great enlargement of the bile-ducts by the chronic inflammatory thickening and dilatation is clearly seen, the ducts standing out as broad white fibrous bands. One of these has been opened, and from the oval aperture some actual flukes are escaping. On the left-hand part of the photograph can be seen a considerable part of the liver, which has become entirely transformed into fibrous tissue and which shows the cirrhotic condition. There is much increase in the connective tissue throughout the whole organ, but certain parts are seen to be quite fibrous, and in these the pressure of the contracting fibrous tissue has entirely obliterated the hepatic elements proper, rendering the liver in those portions functionless.

FIG. 7.—CROSS-SECTION OF LIVER, SHOWING CAVITIES FORMED BY HYDATID CYSTS (T. ECHINOCOCCUS). (LEIGHTON.)

The illustration of the same condition in the liver of a sheep (Fig. 6) also indicates the profound structural changes which the fluke causes. The bile-ducts in this case are not so obviously thickened and enlarged, but the cirrhotic condition of the organ is equally well seen, and here again parts of it are the seat of a substitution of connective-tissue growth at the expense of the liver-cells. The whole surface is rough and irregular and contracted in various directions. The illustration is from a long-standing case, in which the cirrhotic change is well advanced.

It is quite possible to cut out the bile-ducts in which the gross changes have taken place, and leave the liver tissue proper, which may be but slightly if at all affected. Where, however, the cirrhotic condition has involved the greater part of the organ the liver should be seized and destroyed ; in a word, the healthy portion may be passed, the affected portion condemned.

HYDATID CYSTS

These cysts, which are of fairly common occurrence in the livers of cattle, constitute the sexual stage of the tape-worm, *Tænia echinococcus*, which passes its adult stage in the intestines of the dog. The tape-worm itself is extremely small, being about one-third of an inch in length at the most and consisting of four segments, the posterior of which alone reaches maturity. In this segment there are produced some five thousand eggs. These eggs being discharged from the intestines of the dog are ingested by other animals, and on reaching various parts of the body give rise to the cyst which is known as hydatid. The disease occurs in man as well as animals and is of considerable danger. It is but rare in this country, but in other parts of the world it is relatively common, especially in Iceland.

It would appear from investigations which have been made upon the point that the disease in man is directly proportionate to the distribution of the cysts among the domestic animals and also bears a distinct relationship to the number of dogs present in any locality and the closeness with which these animals are associated with their human owners.

Forms of Hydatid Cysts. Two distinct forms of cyst are produced by the larvæ of this tape-worm. One is known as *Echinococcus polymorphus*, in which form the parasite produces *one single cyst* surrounded by a wall of connective tissue. Within this cyst, however, there may be

FIG. 8.—TÆNIA ECHINOCOCCUS OF DOG
a. Natural size. *b*. Enlarged. *c*. Cysts.

Fig. 9.—Liver of Pig with Hydatid Cysts
Anterior and posterior surfaces.

other cysts known as daughter cysts (Fig. 12). The second form is known as *Echinococcus multilocularis* and gives rise to a somewhat different appearance. In this the daughter cysts themselves are produced by constriction and in their turn they produce others by peripheral growth. Moreover, the daughter cysts in the second form do not remain within the general fibrous capsule of the whole cyst as they do in the first case, but having become constricted are quite separate from the mother cyst by means of intervening connective tissue. As a result, the vesicles themselves do not attain any very large size.

In the latter stages of this form, when the connective tissue has become hard and firm and possibly infiltrated with a deposit of lime salts, the

whole arrangement is very *apt to be mistaken for a mass of tubercular disease.* A close study, however, of the arrangement of the structure will serve to distinguish the two. According to Mangold these two forms of hydatid cysts are not produced by one and the same parasite, but by two distinct species of tæniæ.

The unilocular cyst known as *Echinococcus polymorphus* is that which most readily attracts the attention of the inspector, producing vesicles or bladders of a rounded shape in various organs which are filled with fluid surrounded by a membrane and a fibrous wall. Should these cysts be upon the surface of the liver the membrane projects a little in a convex manner, and if the cysts be cut across, it gives the appearance of a section of a sphere (Plate XXI.).

The membrane (which can be removed) is thick and wrinkled, and of a whitish or bluish grey colour. The earlier the stage of the parasite the thinner and more transparent is the membrane, becoming quite opaque in the later stages.

The most common form in which this cyst is encountered is that of a cyst which contains nothing but fluid, having a smooth lining to its wall. This is fairly frequent in all the food animals. The cyst itself varies in size from that of a large shot to that of an orange, or even much larger, probably reaching its largest development in cattle.

The most common organs affected are the liver, lungs, and spleen; but in addition, the heart, the kidneys, the peritoneum, the medullary cavity of bones, lymphatic glands, the udder, and even the muscles, brain, and eyes may be affected.

Of all these situations by far the most important are the lungs and the liver; and in cattle and sheep perhaps the lungs are more frequently affected even than the liver (Fig. 8, p. 992).

No matter how extensive the presence of the hydatid cysts the carcase itself usually shows no deterioration, and this despite the fact that the liver containing these hydatid cysts may be enlarged to many times its normal size.

FIG. 10.—T. ECHINOCOCCUS
Intestine with worms.

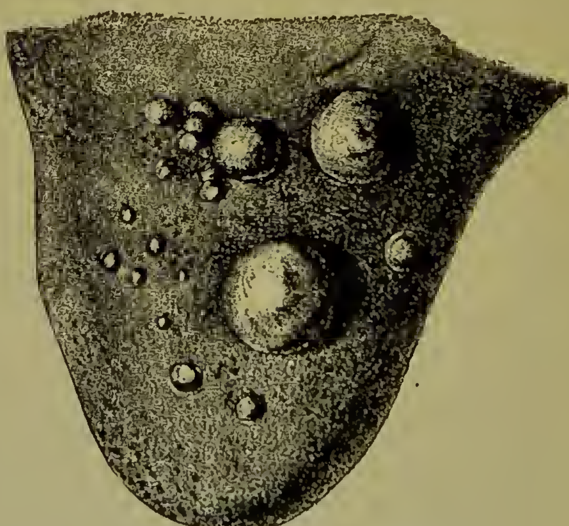


FIG. 11.—PORTION OF LIVER OF PIG, SHOWING ECHINOCOCCUS CYSTS

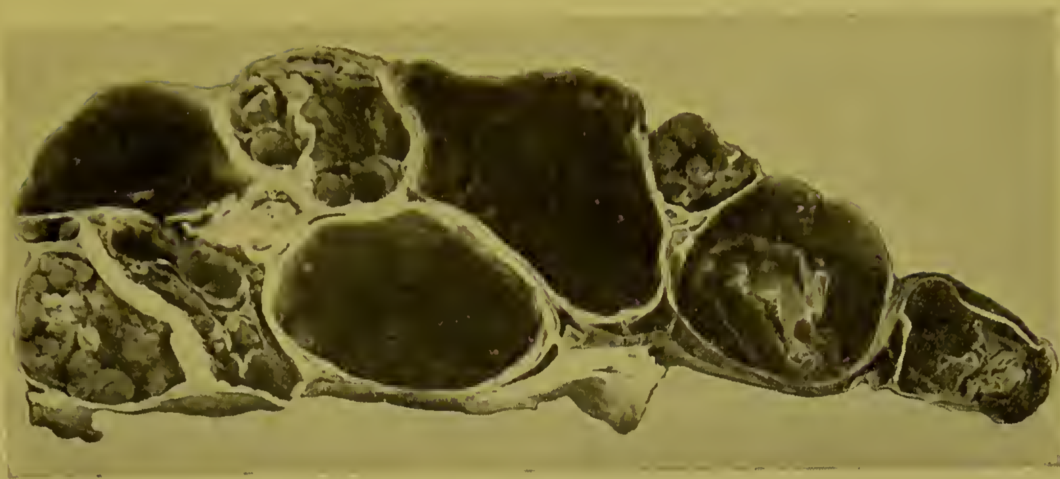


FIG. 12.—LIVER OF COW
Parenchyma almost entirely replaced by large hydatid cysts, some containing daughter cysts. (Preparation by S. Delépine.)

Growth of Hydatid Cysts. The development of the cysts is slow. Four weeks after the invasion of the liver, the cyst is one-twenty-fifth part of an inch long, increasing to from one-twentieth to one-tenth of an inch in eight weeks. After four or five months the cyst is the size of a hazel-nut, and only at that time do the capsules which contain the head of the young parasite begin to appear. The true cyst wall is lamellated in structure, consisting of two layers of gelatinous consistence, around which externally is a firm capsule of fibrous connective tissue. The contents of the cysts are clear serous fluid ; the largest ones weigh as much as 10 lb. The scolices are developed from the germinal material in the wall of the cyst, each germinal area producing up to twenty-two scolices, and one bladder frequently containing as many as one thousand.

Livers in which these cysts are present are always more or less enlarged, presenting concave lumps on the surface, which indicate the presence of the cysts. A liver, the normal weight of which is from 10 to 11 lb., may increase in bulk so enormously as to weigh as much as 150 lb., a case being on record of one such liver which contained not less than 2400 cysts. A pig's liver of normal weight (about 4 lb.) may be so enlarged as to weigh 50 lb. The serous coat of the liver shows considerable thickening over the site of the cysts, and by means of the inflammatory processes set up becomes firmly adherent to the structures around it. If the cysts die out, the contents gradually become yellow and fatty, containing purulent matter, and finally calcified.

Relative Frequency in Organs. Peiper states that echinococcus cysts occur in the lungs and liver of cattle in the proportion of eight to seven, while in sheep they are more frequent in the lungs than liver in the proportion of three to two, and in swine they are rare in the lungs as compared to the liver in the proportion of eight to one.

Echinococcus Veterinorum. The cystic stage of the parasitic tapeworm, *Tænia echinococcus*, of the dog, is often described as *Echinococcus veterinorum.* This cystic stage produces cysts in all the domestic

animals in varying frequency and in varying numbers in each case. Sometimes there are found only one or two cysts, sometimes a good many, occasionally immense numbers. An instance of this last is seen in the photograph of a pig's liver, supplied to the writer by Professor Leith, of Birmingham, in which the whole liver is seen to be absolutely riddled with the cysts (Fig. 14). It is, however, not in swine, but in cattle and sheep, that the condition is most common in this country, and, in the experience of the writer, more in cattle than sheep. The relative frequency of *Echinococcus veterinorum* in any locality will depend upon that of the adult parasite in the dog.

It will be remembered that the cysts from this parasite take various forms, and that some authorities hold that two worms are responsible for them, one for the form usually known as *Echinococcus polymorphus*, and one for that known as *Echinococcus multilocularis*. An illustration

Fig. 13.—Liver of Sheep with Hydatid Cysts
(Preparation by S. Delépine.)

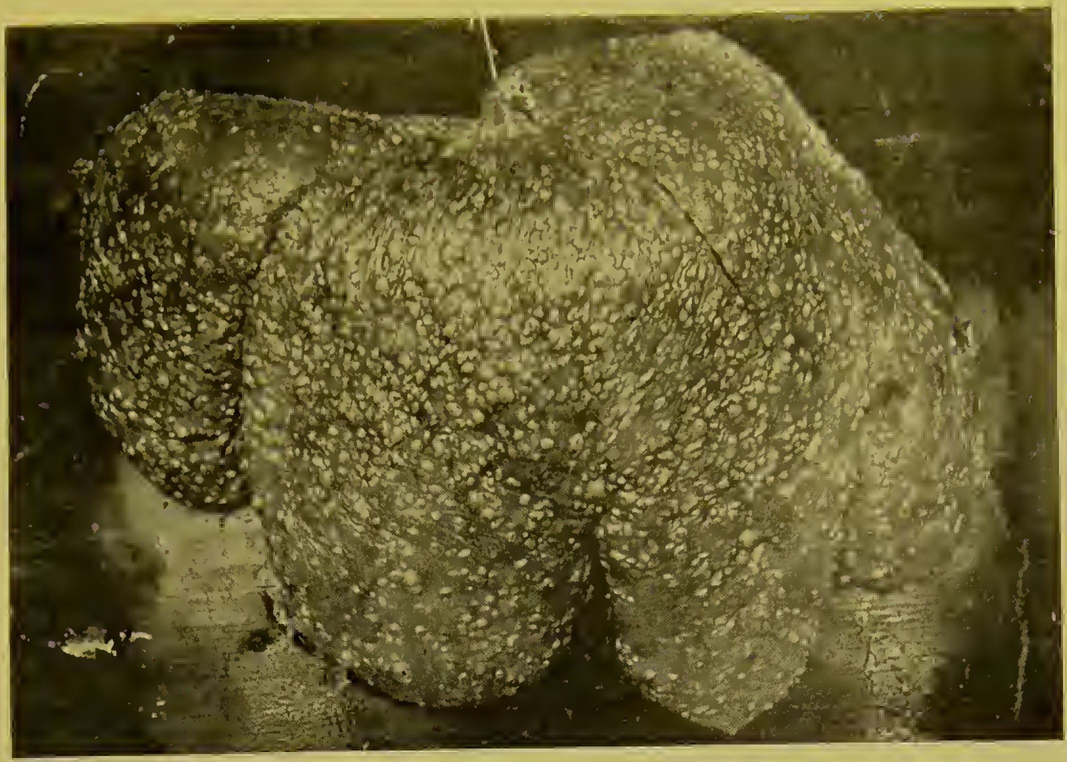


FIG. 14.—PARASITIC INFECTION OF LIVER OF PIG
The liver is riddled with *Echinococcus veterinorum* (*T. echinococcus*).
(Professor Leith's Collection.)

of *E. polymorphus*, which takes the form of single round cysts in various organs, is seen in the coloured Plate XXXI., in which case the cyst is in a portion of liver, lying superficially. The colour of such cysts is greyish blue when young to pure white in the old cysts, in the latter of which there is more fibrous tissue on the walls.

COCCIDIOSIS IN LIVER OF RABBITS

Coccidiosis is caused by the presence of a parasite, the *Coccidium oviforme*, in the bile-ducts of the liver, the disease being frequently found in young rabbits during the summer. It also occurs in the livers of calves, pigs, and sheep.

The fully developed parasite is an egg-shaped unicellular structure, with a double contour, measuring from one-seven-hundredth to one-fifteen-hundredth of an inch. In the liver they attack the epithelial lining of the bile-ducts, there multiplying by forming spores. A section of a rabbit's liver affected with coccidium shows the presence of a number of yellowish white nodules or cysts, which may be aggregated together to form a lump, and which present an appearance not unlike that of tuberculosis. The nodules contain a thick, creamy, yellowish liquid, which may become caseous, and amongst this under the microscope may be found the egg-shaped parasites. The whole nodule is surrounded by a firm connective-tissue capsule. Similar appearances to that found in the rabbit have been described in the livers of swine by Johne and Ostertag, the latter of whom states that these

occur quite frequently in the livers of hogs, varying in size from a pea to a walnut, and accompanied by a cirrhotic condition of the liver around. These structures always contain unicellular parasites, not, however, in such large numbers as are found in the rabbit, and it is still undecided as to whether they are identical with *Coccidium oviforme* or not.

In the present stage of our knowledge it is impossible for us to say whether any serious or injurious effects are likely to follow from eating organs containing coccidia, and in the absence of any experimental investigations, which alone would settle the question, the only safe procedure for the meat inspector must be to seize all organs thus affected and order them to be destroyed.

Other Parasites of the Liver. Another parasitic cyst which occurs in the livers of swine, sheep, and calves is that of *Cysticercus tenuicollis*, which when present is apt to be extremely numerous. Numerous cysts in such cases occur in other parts of the body, especially in the abdomen and thorax, causing both peritonitis and pleurisy. *Cysticercus pisiforme* occasionally occurs in the liver of swine. Other parasites, which may be found in the liver, are so rare that they need not be mentioned here, and in all cases the judgment of the meat inspector in connection with livers containing parasitic cysts will be the same, namely, the seizure of the organ.

Tumours of the Liver. Tumours of the liver are not common in the domestic food animals, though they are fairly frequent in dogs and horses. In cattle, perhaps, the most common tumours which are found are sarcomata and melanotic tumours, as well as the angioma which has already been described. It need only be stated here that in the case of any new growth being detected in connection with the liver by the inspector, the organ should be seized and destroyed.

Abscess of the Liver. Abscesses in this organ may be found as the result of the invasion of the organisms of suppuration in cases of general pyæmia, or as a secondary infection from any suppurative process which is taking place in another part of the body. They present no difficulty in diagnosis and call for the seizure and destruction of the organ.

Abscesses are perhaps most common in cattle, the infection coming either from the bowels or from the umbilical vein and navel-ill in calves. They may also be caused by foreign bodies and mechanical injuries, or from the spread of inflammatory processes around. They may be multiple or single. Occasionally they rupture, discharging their contents into the abdominal cavity.

Acute Yellow Atrophy. This very acute form of inflammation of the substance of the liver is generally associated with various forms of poisoning. The organ shows a softening and yellow coloration, the cells being fatty and degenerated, together with extreme bile-staining and hæmorrhages. The organ in such a case must obviously be destroyed.

Multiple Atrophic Superficial Areas. Every now and then the meat inspector may encounter a somewhat curious condition on the surface of the liver in cattle which, unless his attention has been drawn to it,

may somewhat puzzle him ; especially should it happen that he has not the opportunity of seeing the carcase from which the liver was taken. In the condition referred to we find a varying number of irregular depressions scattered over the convex surfaces of the liver, these depressions varying very much in size, configuration, and depths, and being perfectly smooth on their sides and floor. They give the appearance of having been produced by pressure, and this is actually the case. If the carcase from which the liver came is available for comparison, it will be found that all these numerous depressions on the surface correspond to an equal

FIG. 15.—CYSTICERCUS CYSTS IN THE LIVER OF THE PIG
(Dr. Hope's Collection.)

number of tubercular lumps or nodules upon either the wall of the abdomen, or the surface of the diaphragm, or other anatomical structures with which the liver has been lying in actual contact. Each depression is an actual model of the surface of the nodule which fitted into it and is, therefore, an example of the general pathological law, namely, that pressure which is continuous (but not sufficiently severe to cause necrosis) produces atrophy. This is not the common result of continuous contact with tubercular masses, the usual thing being to find that the tubercular process spreads to the surface of the liver, there producing more nodules which develop in the serous covering of that organ, and which can be removed from the surface of the liver by tearing off the capsule. Why

it should happen now and then that we find depressions from atrophy instead of nodules from spread by direct contact is not very easy to explain. Possibly, however, in the process we are describing, the nodules are of slow growth and exhibit no inflammatory reaction around them, thus producing only results due to their pressure.

Bacterial Necrosis of Liver. In Fig. 16 is represented a cross-section of a large bovine liver in the disease of bacterial necrosis. The figure, which is photographed from a preserved specimen, does not show the necrotic areas quite so distinctly as one would desire, because the preservation of the specimen has caused it to lose much of its colour ; but if it be observed closely there will be seen numerous round, pale patches which are sharply defined from the rest of the liver tissue. The circumference of these patches varies in size from that of a sixpence to that of a shilling, and where these come in contact with each other at their periphery there is produced a figure-of-eight appearance The liver itself from which this cross-section was made was very greatly enlarged, as is quite usually the case in bacterial necrosis (*see also* Plate XXVII.).

Multiple Hydatid Cysts. Fig. 7 is a photograph of a section of a liver in which there are seen numerous cavities, each of which is a hydatid cyst. The dense fibrous outer layer of the cysts can be distinctly recognised. The contents of the cyst had been removed, but the appearance of such a cyst when projecting from the surface of an organ is represented in the liver in the coloured Plate XXI., and in the lungs in the photograph in Fig. 8, p. 992.

THE KIDNEY

Inspection of Kidneys. Considering the commercial importance and value placed upon the kidneys of cattle, sheep, and pigs, and also the fact that these organs are subject to a great variety of inflammatory and other diseases, we cannot help thinking that they do not receive that attention at the hands of the meat inspector that they deserve. In well-nourished carcases they are always concealed amongst a mass of fat, in fact, the quantity of fat surrounding the kidney is one of the tests of the condition of the carcase. This fat should be separated from off the surface of the kidney immediately after slaughter before it sets firm, otherwise there is some trouble in exposing the organs. It will be remembered that the kidneys of pigs and sheep are bean-shaped and smooth on the surface, while those of cattle are elongated and lobulated on the surface. In cattle, too, the kidney on the right side is fixed to the abdominal wall, that on the left being unattached. In weight the kidneys of cattle are about 1½ lb. The normal colour should be reddish brown, the surface smooth and glistening, showing numerous minute red spots on section.

Conditions demanding Seizure of Kidney. The various conditions which call for seizure and condemnation of these organs are principally those of malformation, deposits of calcareous matter or actual calculi, fatty degenerations and hæmorrhages, multiple infarcts, a variety of

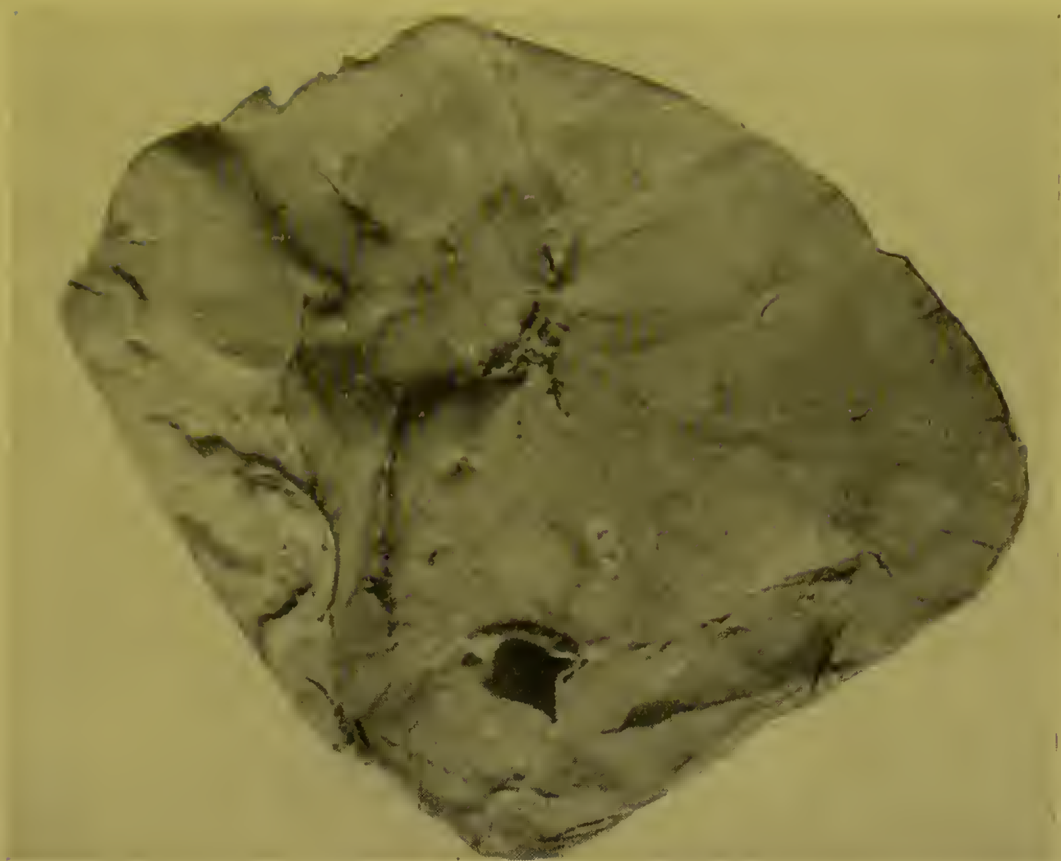


FIG. 16.—A SECTION OF A PRESERVED BOVINE LIVER FROM A CASE OF BACTERIAL NECROSIS

Note the scattered round areas indicating the necrotic patches. (Leighton.)

inflammatory conditions, suppurative changes, tumours, tuberculosis, and occasionally parasites.

Malformations. These do not necessarily involve the kidney substance in actual pathological changes. Thus we may have a *congenital hypoplasia* of one kidney, rendering it very small, with a *compensatory hypertrophy* of the other; or the condition, known as *horse-shoe kidney*, in which the two kidneys are joined together either by fibrous tissue or kidney substance, in neither of which need there be any interference with the integrity of the kidney tissue. On the other hand, in *congenital cystic* kidney the whole kidney substance is occupied by a number of spaces, and the organ is worthless.

Renal Calculi. It is not uncommon to find a calcareous deposit in the median portion of kidney in the sheep, whilst in cattle actual calculi occur in the pelvis of the kidney (Figs. 17 and 18).

Degenerations. In all forms of acute inflammation and in many bacterial conditions the cortex and the kidney shows a pale colour, due to fatty degeneration. The kidney tissue is a highly specialised one and reacts very readily to the toxic influences of any substances circulating in the blood, which have deleterious effect upon cell life.

Infarcts. These are quite common in these organs, appearing as wedge-shaped masses with the base to the surface, the colour being at

first dark and gradually becoming pale or yellowish, ending either in the formation of fibrous tissue or (in cases of septic infection) in small abscesses.

Inflammatory Conditions. A very wide group of clinical diseases are classified under inflammations of the kidney, and of these some are associated with general conditions of the body which are reflected in the condition of the meat itself, whilst others are more localised and are not associated with changes elsewhere. It would be beyond the scope of this work to enter into a detailed description of the various forms of *nephritis.* It will be sufficient to say that the condition may be either acute or chronic, simple or septic, affecting principally either the secreting structures of the gland or its interstitial connective-tissue elements. In all the acute forms of inflammation of the kidney the organ is more or less swollen, whereas in the long-standing chronic conditions the kidney gradually becomes smaller and contracted, as do all cirrhotic organs.

In acute forms of inflammation the capsule is tense and strips off readily from the kidney substance, which is congested and softer than normal. In the chronic forms the capsule is more or less firmly adherent to the kidney substance, from which it can only be stripped by tearing the latter, and the gland itself is found to be in varying degrees of firmness and density.

In septic conditions there may be a number of small or even minute abscesses, especially in the cortex of the kidney, arising either from the presence of organisms primarily in that organ itself, or from septic emboli brought from elsewhere, or from the spread of a septic process upwards from the bladder. It is in these last cases particularly, namely, those of spreading septic conditions, that the meat inspector will find associated changes in the meat of the carcase which may call for condemnation. On the other hand, it frequently happens that with small abscesses in the kidney substance there is no trace of disease elsewhere, and therefore no occasion for seizure. Even large renal abscesses in cattle may have none but quite local effects.

Purulent conditions, in which the whole organ contains many abscesses, and both kidneys are involved, are found especially in swine and calves, the origin being either ulcerative endocarditis, general pyæmia, or abscess in the lungs.

Another condition, which is not uncommon in calves, is that known as "white spot" kidney, which is supposed by Kitt to be a progressive process of induration, either from the very beginning perhaps caused by organisms which are not pyogenic, or else the condition may be a late stage of septic nephritis. In any case, both kidneys are affected with a number of wedge-shaped, scattered, whitish areas which are very characteristic.

Numerous theories have been put forward to account for this condition. It is a local change only, calling for condemnation of the kidneys alone, the meat apparently not being affected.

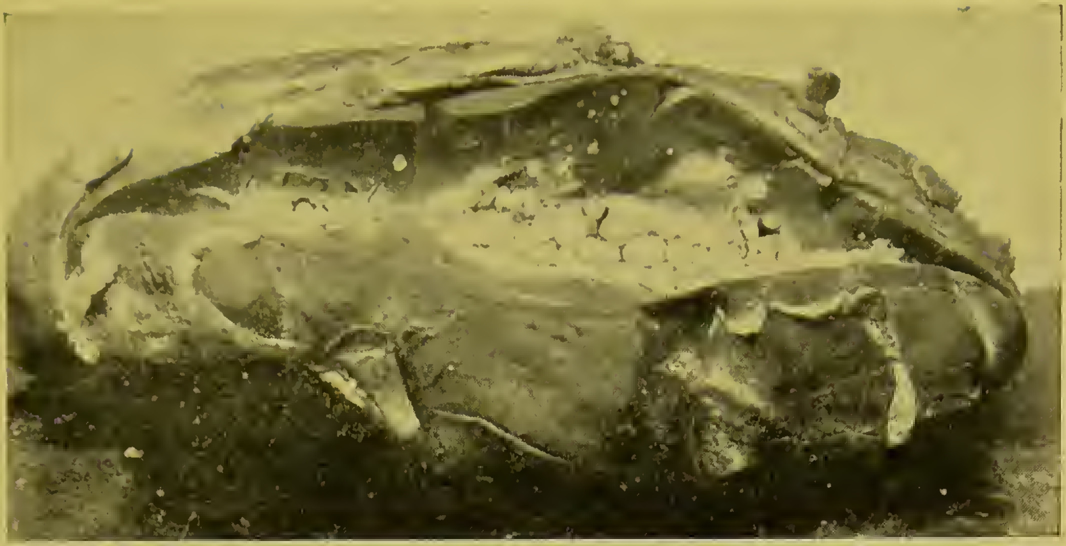


FIG. 17.—BOVINE RENAL CALCULI
In this kidney and the other from the same cause (also figured) there were an enormous number of calculi of various sizes. (Leighton.)

Inflammation of the pelvis of the kidney, or pyelonephritis, occurs not uncommonly in cattle, either on one or both sides. The kidneys are enlarged, and the pelvis distended with a purulent exudate along with small abscesses in the cortex. The condition is due to a specific organism, the bacillus of the bovine kidney.

In advanced cases the carcase may be found to be extremely emaciated, and should there have been any retention of urine the carcase should be condemned.

Tumours. Sarcomata and carcinomata both occur in the kidneys, as well as some benign growths. These malignant tumours may attain

FIG. 18.—BOVINE RENAL CALCULI
From the same case as Fig. 17. (Leighton.)

a large size and are generally part of a general tumour growth throughout the body.

Tuberculosis. Tubercle of the kidneys is generally miliary, at first the tubercles of a greyish colour being scattered throughout the organ. As in other organs the central portion of the tubercle becomes caseous. The disease is sometimes restricted to one lobule in cattle, or may affect several (Figs. 19 and 20).

Parasites. The kidney is not a common seat for the occurrence of parasites, except that known as *Eustrongylas gigas*, which has its normal habitat in these organs. Occasionally *hydatid cysts* are found, and sometimes a *cysticercus* of one or other of the tape-worms. Other parasites are quite an exceptional occurrence.

Fig. 19.—Kidney of Cow, with Large Solitary Tubercular Mass
Natural size. (Preparation by S. Delépine.)

HYDRONEPHROSIS IN THE DOMESTICATED ANIMALS

The present writer has been specially interested in this subject as the result of specimens which have come under his own notice, some of which he has described in the *Journal of Comparative Pathology.* Two such cases were those which follow, quoted here from that journal. The other was in a collie dog, so that the condition evidently occurs in various species of animals.

" In the case in the pig the hydronephrosis was double, and the condition of the kidneys is well shown in the photograph here reproduced (Fig. 21) of one of them, the other being precisely similar. The pelvis is much dilated, the whole of the kidney being converted into a multilocular cyst, surrounded by the atrophied cortex. The ureters were very

greatly thickened, but the thickening was extremely irregular. In the right ureter, about half-way between the kidney and the opening of the ureter into the bladder, the lumen was entirely occluded by great fibrous thickening of the ureter walls. Nearer the opening into the bladder the walls were considerably thinner. The whole length of the ureter was marked by tortuosities, and here and there by pouching. The fact that the hydronephrosis was double indicated that the origin of the condition would be found in all probability in the bladder, and examination of that organ proved this to be the case. The bladder itself, on coming into my hands, was distended, and when opened was found to contain a large quantity of thick purulent fluid, obviously septic. The mucous membrane was thrown into numbers of thick folds, on which was a deposit of purulent matter which washed off with some difficulty, leaving a bare roughened wall beneath. But the most remarkable point in the bladder was the great thickening of its walls.

FIG. 20.—KIDNEY OF COW. DISCRETE MEDIUM-SIZED TUBERCLES
Tubercle bacilli found. (S. Delépine.)

Anteriorly and inferiorly the thickening of the wall was very marked, reaching as much as one-third of an inch in the distended condition. Superiorly the thickening was also obvious but not so great. Immediately round the point of junction of the urachus and bladder wall the thickening reached nearly half an inch, diminishing from that point in concentric fibrous laminæ.

"The condition, then, was that of a chronic septic cystitis, which had gradually spread upwards along the two ureters, causing a chronic inflammatory thickening of these as it went on, and ultimately reaching the pelvis of the kidney. Gradually the pressure exerted by the obstruction to the outflow of urine began to act upon the kidney pelvis, but the animal was slaughtered before complete atrophy of the cortex had taken place.

"A condition of dilatation of the pelvis of the kidney with suppuration added is spoken of as pyonephrosis; but in this case there did

FIG. 21.—HYDRONEPHROSIS OF KIDNEY, PIG
(Leighton.)

not seem to be actual suppuration in the pelvis itself, which contained turbid, but not purulent, fluid. I retain, therefore, the term hydronephrosis for descriptive purposes.

"It so happens that, of three cases I have examined—one each in

FIG. 22.—HYDRONEPHROSIS. EXTERNAL SURFACE OF RIGHT KIDNEY
(Leighton.)

FIG. 23.—HYDRONEPHROSIS. RIGHT KIDNEY ON SECTION, SHOWING CYSTIC APPEARANCE
(Leighton.)

the dog, pig, and cow—this one in the pig was the only one in which I had the opportunity of examining the bladder also. But in this particular case the bilateral nature of the hydronephrosis would have been sufficient to locate with fair probability the seat of the cause, even had the ocular demonstration not been forthcoming in the state of the bladder.

"The causes of the condition may conveniently be divided into two groups: (1) those situated above the point of entrance of the ureters into the bladder; and (2) those situated below that point, either in the

Fig. 24.—Hydronephrosis of Kidney
(Professor Leith's Collection.)

bladder or urethra. To these may be added a third less common group caused by pressure exerted from without upon some part of the urinary tract.

"The various causes which may be responsible for unilateral or bilateral hydronephrosis may be enumerated as follows:

"**Unilateral Causes.** Causes of obstruction in the outflow of urine situated above the point of entrance of the ureter into the bladder will produce a unilateral hydronephrosis of the kidney of that side. Such are: deformity of ureter, occlusion, contraction, twist, kink, calculus impacted, pressure of pelvic tumour, pelvic scar tissue, uterine displacements, pregnancy.

"**Bilaterally Acting Causes.** Causes of obstruction below the points of entrance of the ureters into the bladder will produce a bilateral hydronephrosis. Such are: any vesical or urethral obstruction, usually incomplete; calculus in bladder or urethra; enlarged prostate; pressure of tumour; stricture; chronic cystitis.

"*N.B.*—Bilateral hydronephrosis may, in rare instances, be caused by a similar condition in both ureters—*e.g.*, a calculus in each. In a large proportion of hydronephrosis there is some congenital defect present.

"The third case of hydronephrosis to which I wish to refer occurred in a cow, and was remarkable for the degree to which the kidney tissue had atrophied, and the immense size of the cyst into which the kidney had been converted. The contents in this case were clear fluid, and measured several gallons. The case was undiagnosed in life, the specimen coming to me from the slaughterhouse.

"There was no history obtainable in this case, but the enormous distension of the kidney and the amount of the cystic contents, together with the fact that the other kidney was in a normal condition, all point to the conclusion that the case was one of sudden onset and great acuteness. In all probability it was associated with a kink in the ureter of that side, and it is regrettable that one could not have had the opportunity of examining the whole urinary tract. Although there was an appearance of kidney still to be seen in the specimen, the resemblance was only superficial. There was no kidney tissue left, nothing but the exaggerated outline. It seems strange that the presence of such an immense swelling, fluctuating as it must have been, should not have been observed, but the thickness of the skin and the strength of the abdominal walls in cattle prevent the tumour becoming as palpable as would be the case in a corresponding condition in a human being. Moreover, pain is often absent and even tenderness but little marked, while hæmaturia is rare and the urine (from the other kidney) normal.

"I have already referred to the ætiology of this condition in the case of the pig previously described, and the only further point that one would like to raise is this: Is hydronephrosis so rare in domestic animals as we are apt to think? At any rate, here is the fact that there have passed through the hands of one observer cases in three different species (dog, pig, and cow) within a comparatively short period. That may, of course, be a mere coincidence, but, on the other hand, it may point to the condition being more common than is supposed. The absence of pain, or obvious swelling, or urinary symptoms also suggests that many cases escape observation during life. It would be of interest to have the experience of inspectors and slaughterers upon the matter." *

Some time after the appearance of the above in print the writer received a letter from Mr. Hedstrom, one of the veterinary meat inspectors at the Gothenburg slaughterhouse, in which he stated that a considerable

* *Journal of Comparative Pathology* (Leighton).

number of cases of hydronephrosis came under his notice, and that in his experience the condition occurred most frequently in pigs.

RENAL TUMOURS OF PIGS

Although tumours of this organ are comparatively rare as far as the meat inspector is concerned, yet there is one variety to which attention has been recently drawn by Mr. Enos Day, Veterinary Inspector in Chicago, to which brief reference may be made here. The growth has been described by him as *embryonal adenosarcoma,* on account of its resemblance under the microscope to somewhat similar tumours which have been described in man. Day first found this condition in a pig which had been condemned before slaughter on account of its emaciated condition, and also because a large swelling could be felt through the abdominal wall by the hands. On post-mortem examination this was discovered to be an enormous growth in the kidney weighing 25 lb., and in another case most recently observed by the same writer a similar tumour reached the enormous weight of 60 lb. Mr. Day gives the following facts about these growths. They take the form of large encapsulated, irregular masses, affecting, as a rule, only one kidney but sometimes both. The growths are comparatively rare, and when they do occur they are in young hogs up to eighteen months of age, in which animals they grow very rapidly to a large size. Their occurrence appears to be restricted to hogs, there being no record of these tumours in cattle or sheep. From the fact that Mr. Day has received no fewer than eight specimens of this kind in eight months at his laboratory in Chicago, it would appear that in America at least these tumours are not so rare as to be a negligible quantity.

The development of the tumour always begins within the kidney substance, usually near the pelvis. The kidney tissue gradually becomes compressed as the tumour grows, and ultimately atrophies from pressure to such an extent that in the later stages there may be no kidney tissue left except the thin covering forming a capsule to the tumour. On section the growth is seen to consist of a fibrous dense capsule, from which strands of fibrous tissue project into the tumour mass separating the latter into indistinct lobules.

The tumour substance itself is of a light grey colour mottled here and there with blood-stained patches, and in the very large specimens necrotic areas are found towards the centre. The average weight is about 10 to 15 lb.

When examined under the microscope these renal tumours of swine are found to consist partly of connective tissue and partly of epithelial elements, distributed in such a way that in some places the appearance presented is that of an adenoma, while in other places the proliferating connective tissue suggests a sarcoma. The two types of tissue, however, do not blend, and this gives rise to the opinion that they originate separately.

THE SPLEEN

Tuberculosis of Spleen. By far the most common condition which comes under the notice of the meat inspector in connection with the spleen is the tubercular inflammation of its peritoneal coat, which often suffers to a more marked extent than other parts of the peritoneum. The appearances presented are similar to those of tuberculosis of any serous membrane, and the observer will be frequently struck with the fact that the process is limited to the covering of the organ, distinctly proving that the infection is purely by means of the lymphatics (Fig. 25, p. 886). When tuberculosis occurs in the splenic pulp it is usually in generalised tuberculosis in swine, or in cattle under four years of age, in which case the organ usually exhibits tubercular areas (*see* Plate XXII.).

In older cattle, curiously enough, the spleen seems to escape, whereas the kidney more commonly suffers.

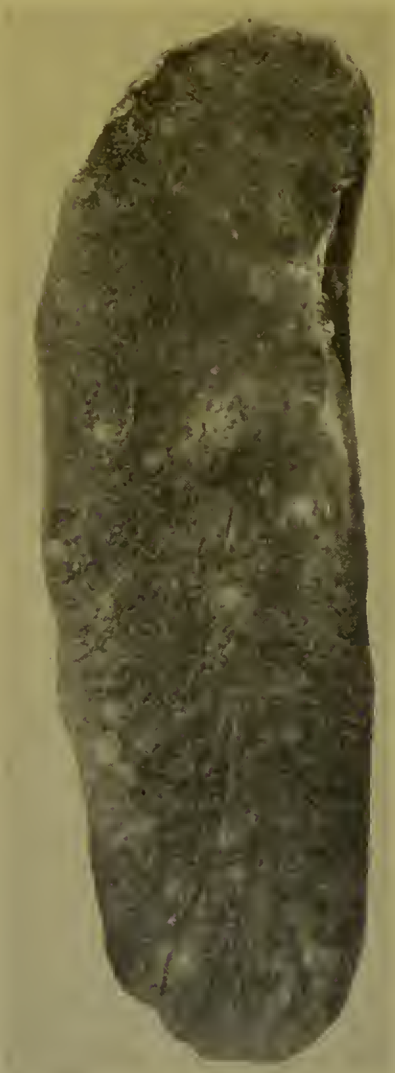


FIG. 25.—SPLEEN OF HEIFER, WITH TUBERCULOUS NODULES IN PARENCHYMA
Tubercle bacilli present.
S. Delépine.)

Anthrax in Spleen. Septicæmia. By far the most important and serious condition of the spleen, as opposed to other organs, is the acute general enlargement which occurs particularly in anthrax and also in swine erysipelas, septicæmia, and pyæmia. It occasionally happens that an animal is slaughtered while suffering from anthrax, the disease not being recognised by those concerned, and is brought into the slaughterhouse as a case of emergency slaughter. In all such cases the inspector should be present when the carcase is opened and, failing any external signs which would indicate the presence of anthrax, he will be at once struck when the abdomen is opened with the immense general enlargement of the spleen. In such a case the inspector would, of course, stop the whole proceedings and take every precaution for the destruction of the carcase and the disinfection of the booth and men who have been in contact with the carcase.

Infarcts in Spleen. The spleen may also be considerably enlarged as the result of the presence of numerous infarcts produced by emboli which take their origin on the heart-valves in cases of endocarditis. These infarcts show themselves as raised areas on the surface of the organ, at first red in colour, later becoming pale as the process of necrosis sets in.

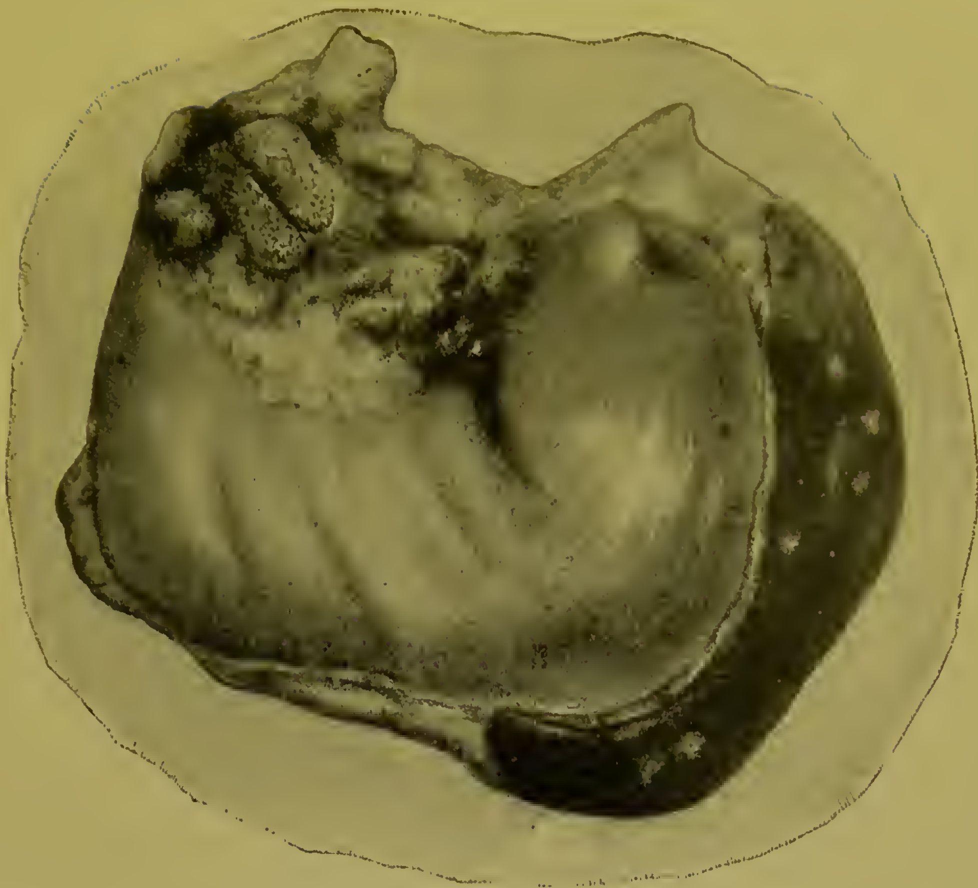


FIG. 26.—TUBERCULOSIS OF THE SPLEEN (IN NATURAL POSITION) IN THE PIG

Rotation of Spleen. Occasionally the spleen becomes altered in shape as the result of rotation, particularly in swine, in which animals the organ is somewhat more loose than in cattle. The result is an anæmia from twisting of the vessels, which is, sooner or later, followed by shrinking and necrosis.

Hæmatoma of Spleen. Every now and then a spleen is encountered which shows upon its surface a circular swelling varying in size from a marble to a cricket ball, dark red in colour and soft in consistence. If these swellings be incised they are found to contain blood, and are in fact of the nature of hæmatoma, being caused by a local rupture of vessels at the spot.

Parasites, Tumours, and Abscesses of Spleen. Certain parasites occur in the spleen, particularly echinococcus and occasionally a liver-fluke.

Of the tumours which attack this organ sarcomata and carcinomata both occur, generally as secondary growths from another source (Fig. 27). Occasionally the sarcomata are numerous in the organ, and sometimes of the melanotic variety.

Abscesses are found in the spleen, as in other organs, in cases of general pyæmia. Lastly, it is not uncommon to find a spleen in an extremely fibrous or cirrhotic condition, especially in old animals.

The meat inspector has no difficulty in forming his judgment in

FIG. 27.—SPLEEN OF PIG WITH MULTIPLE SARCOMATA (Leighton.)

connection with this organ, it being a safe general rule to destroy it in the presence of any of the abnormalities which occur.

The Uterus. Septic conditions of this organ should receive close attention at the hands of the meat inspector, for the reason that the meat of carcases, where such conditions are present, is highly unfit for consumption. The actual condition present is that of a *septic metritis* occurring after parturition, at which time the organ is a most favourable seat for bacterial and septic processes.

A chronic catarrhal inflammation of the uterus also occurs in which there is a slimy spread of purulent discharge frequently accompanied by emaciation of the animal, and in all such cases the meat should be withheld from sale.

Tumours of this organ are quite common, being either of the myoma type or less commonly malignant.

Tuberculosis attacks the uterus most commonly as a spread to that organ from a general peritoneal infection.

Inspection of the Uterus. Some very important conditions are to be found in connection with this organ, demanding the careful attention of the inspector. The chief of these are abnormal contents, tearing or laceration from parturition, tumours, tuberculosis, and inflammatory conditions of the uterine mucous membrane. The last of these is by far the most important.

Occasionally in the uterus of an animal, as in that of a human female, there is found a calcified or petrified dead fœtus, or lithotherion. All dead tissues tend to be the seat of the deposition of lime salts, and to this rule a dead fœtus is no exception. This occurrence is merely a pathological curiosity, and is devoid of interest as far as meat inspection is concerned.

Tears or Lacerations. A laceration of the uterus, or cervix, occurring during the progress of a difficult case of parturition may give rise to serious results from hæmorrhage or bacterial infection through the site of the wound, thus leading to a septic peritonitis and death. These latter cases are considered under the heading of septic peritonitis, and always demand seizure.

Tumours of the Uterus. As in human females, these are by no means uncommon and are of the same type, namely, uterine fibroids or muscular tumours. Their histological composition is a mixture of connective tissue and muscle. They are technically termed *leiomyomata.* They are benign and exert no deleterious influence upon the meat. Malignant growths of a sarcomatous or carcinomatous nature are rarely found, and are generally associated with similar growths in other parts of the body.

Tuberculosis of the Uterus. When tuberculosis attacks the uterus it usually does so as a secondary infection from the peritoneum. In such cases the wall of the organ may be completely infiltrated with tubercular material, and may undergo subsequent calcification. Rarely is tuberculosis of the uterus primary, from the act of coition. A third form is described as "embolic tuberculosis," in which the infection is brought to the uterine mucous membrane in the form of an embolus from some primary tubercular area, thus setting up the tubercular metritis or endometritis. The nodules in this case are found under the mucosa or in the wall.

Uterine Inflammatory Conditions. These constitute by far the most

FIG. 28.—A CASE OF ACTINOMYCOSIS IN THE PIG

important uterine conditions from the meat inspector's point of view, and include some of the most dangerous conditions to the public health with which he has to deal. The inflammation may be *simple* or *septic*, the latter being the dangerous cases. The literature of outbreaks of meat poisoning in human beings proves that the meat from cows which have died as the result of septic metritis is highly dangerous and toxic, as the appearance of the carcase would indeed suggest.

A superficial catarrhal inflammation of the mucous membrane of the uterus, which may be chronic or otherwise, produces a slimy, semi-purulent discharge, and may be associated with infectious abortion or with vaginal catarrh. The carcase may be quite normal in appearance and perfectly well nourished, though if the condition is of sufficiently long standing emaciation is present to a certain degree. When this occurs the meat should be seized and condemned.

Septic Inflammation of the Uterus. Septic Metritis. It is this condition of the uterus to which we desire to call special attention. It is by no means uncommon, and the meat inspector who is attached to a slaughterhouse will see it very frequently. It is a puerperal septicæmia, following upon parturition, in those cases in which the contents of the uterus have been imperfectly expelled after labour. The cow is said to have been "imperfectly cleansed."

The frequent occurrence of this septic metritis is no cause for surprise when one thinks for a moment of the kind of environment in which too often the parturition of the cow takes place. This is apt to be by no means a clean one, and quite commonly can only be described as filthy. The only matter for wonder is that the condition is not more common than it is. One can hardly imagine more favourable opportunities for bacterial infection than those in which many cows are calved, and it is only in the most normal cases of labour that infection is likely to be avoided.

It is astonishing how long it takes certain classes of the community to avail themselves of the most valuable discoveries of medical and chemical science, and even the simple matter of antisepsis (not to mention asepsis) is all too rarely attended to in the case of animals where there is no veterinarian in attendance.

Given the occurrence of an abnormal parturition, then, where some portion of the membranes is left in the uterine cavity, it is no wonder that rapid septic decomposition of these contents sets in, followed by rapid absorption into the whole system, giving septicæmia. When the contents of the uterus are examined, they are found to consist of a putrid purulent mass of dead material, which smells abominably. There may or may not be blood mixed with it. The whole contents of the pelvic cavity exhibit acute congestion and are dark in colour. The condition of the peritoneal cavity will depend upon the length of time which has elapsed since the septic decomposition set in. If this be sufficiently long, there will be a general septic peritonitis, with deposit of purulent lymph on the walls of the peritoneal cavity, in which there may be large

collections of septic pus or abscesses. These abscesses, if time permits, will be found to form in various scattered portions of the carcase. The musculature itself exhibits all the signs associated with a fevered carcase, only greatly exaggerated, and the whole carcase is offensive in the extreme.

Nothing worse can come under the inspector's notice, and immediate seizure, condemnation, and destruction are the only possible judgment.

Inspection of the Mammary Glands. It is in cows especially that this gland calls for careful inspection, since in these animals some serious conditions occur, requiring destruction of the gland. The gland is removed from the body in the process of dressing the carcase, but should always be kept for inspection along with the carcase. Simple physiological hypertrophy is found during the period of lactation, followed by physiological atrophy when that function is in abeyance. Just before parturition occurs in cows there is a certain amount of mammary œdema, seen in the oozing which takes place on removal of the skin. These conditions are not of importance.

Tumours of the Mammary Gland. These are rare in cattle and sheep but common in dogs, with the latter of which we are not here concerned. Innocent papillomata on the surface of the udder are, however, common.

Tuberculosis of the Mammary Gland. Tuberculosis in the mammary gland is present in from 2 to 4 per cent. of the total number of tuberculous cows, and is therefore common and important. It may be in the form of a localised nodule in one quarter or several such nodules, or it may take the form of a generalised disseminated miliary tuberculosis throughout part or the whole of the gland tissue. In the nodular form caseation, followed by calcification, is found. In the generalised disease, it is usual to find single quarters affected, giving rise to considerable enlargement. The supramammary glands participate in the infection, a point which is of great diagnostic importance in this condition.

Actinomycosis of the Mammary Gland. This disease is rare in the udders of cattle, while in the case of the pig this gland is the most frequent seat of the disease.

Inflammation of the Mammary Gland. Under this heading come some important morbid conditions which demand the attention of the inspector. On account of the enormous development of the gland, especially in the milking breeds, it is specially susceptible to inflammatory changes, especially of a bacterial nature. Some writers, amongst whom is Ostertag, distinguish between a parenchymatous mammitis or mastitis, affecting the true glandular elements of the organ, and a phlegmonous mammitis or mastitis, which affects especially the connective-tissue stroma of the organ. The really important point, however, is whether the inflammation is septic or otherwise. Simple inflammations are merely of local importance, and the inspector will base his judgment on what he sees in the gland itself. Septic cases are on a different footing, since the infecting agents may have spread from the gland, if that be the primary seat of infection, or may take their origin in some other part of the body arising in the gland secondarily. In the cases of local

inflammation with abscess formation, it will be sufficient to destroy the gland only. Other cases must be dealt with according to the general principles laid down for septicæmias in general. The whole condition of the carcase will demand attention in such cases.

SUMMARY OF MORBID CONDITIONS TO BE NOTED IN MEAT INSPECTION, GROUPED IN THE RESPECTIVE LOCALITIES IN WHICH THEY OCCUR

(1) **Skin**

Wounds, bruises, contusions, emphysema, anthrax, actinomycosis, warbles, decubitus congestion, hæmorrhages, erysipelas, navel inflammations, thickening in boars, black pigmentation, mange and other parasitic affections, œdema, tumours, and ulcerations.

(2) **Mouth**

Mucous inflammations.
Traumatic inflammations.
Foot and mouth disease.
Ulcerative stomatitis.
Cysticerci (muscles).
Acids, Alkalies } Results of.
Diphtheritic (calves).
Œdematous swellings.

(3) **Tongue**

Actinomycosis.
Œdema.
Foot and mouth disease.
Glossitis.
Ulcers.

(4) **Pharynx and Œsophagus**

Pharyngitis.
Anthrax.
Papillomata.
Hæmorrhages.
Swine erysipelas.
Worms.

(5) **Stomach and Intestines**

Gastric inflammations.
Anthrax.
Ulcerations.
Nematode nodules.
Enteritis.
Swine fever.
Parasites.
Tuberculosis.

Parasites of Stomach and Intestines

Cattle

Gastrophilus pecorum.
,, hæmorrhordalis.
Amphistomum conicum.
Strongylus contortus.
,, ostertagi.
,, curtecei.
,, oncophorus.
,, harkeri.
,, retortæformis.
Moniezia expansa.
Pentastomum larvæ.

Sheep

Strongylus contortus.
,, ostertagi.
,, curtecei.
,, retortæformis.
,, filicollis.
Moniezia expansa.

Swine

Filaria strongylina.
Gnatostomum hispidum.
Ascaris lumbricoides.

(6) **Peritoneum**

Calcification.	Peritonitis.
Melanotic deposits.	Hæmorrhages.
Anthrax.	Sarcomata.
Tuberculosis.	Carcinomata.
Emphysema (swine).	Parasites (C. tenuicollis).

(7) **Liver**

Fatty degeneration.	Focal necrosis.
Capillary angiomata.	Rupture.
Atrophy.	Chronic venous congestion.
Jaundice.	Melanosis.
Waxy degeneration.	Hæmorrhages.
Bacterial necrosis.	Interstitial hepatitis (cirrhosis).
Sarcomata.	Adenoma.
Carcinomata.	Tuberculosis.
Echinococcus cysts.	Distomatosis.
C. tenuicollis.	Pentastomum.
Actinomycosis.	Coccidiosis.
Putrefactive decompositions.	Abscesses.
Infarcts.	Bile-staining.

(8) **Kidneys**

Congenital malformations.	Hydronephrosis.
Nephritis.	Pyelonephritis.
Tuberculosis.	Fatty degeneration.
Infarcts.	White-spot kidneys.
Sarcoma.	Carcinoma.
Eustrongylus gigas.	Cysts.

(9) **Testicles**

Tuberculosis.	Botriomycosis.

(10) **Uterus**

Fœtal presence.	Septic metritis.
Tuberculosis	Myomata.

(11) **Udder**

Melanosis.
Simple mastitis.
Septic mastitis.
Actinomycosis.
Œdema.
Tuberculosis.
Tumours.
Echinococci.

(12) **Spleen**

Perisplenitis.
Anthrax.
Abscess.
Sarcomata.
Echinococcus.
Pentastomum larvæ.
Infarcts.
Tuberculosis.
Leucocythæmia.
Tumours.
Carcinomata.
Distomum hepaticum.
Swine erysipelas.
Torsion.

(13) **Larynx, Trachea, Bronchi**

Inflammations.
Tuberculosis.
Syngamus trachealis.
Actinomycosis.
Bronchitis.
Papilloma.

(14) **Lungs and Pleura**

Pleurisy.
Atalectasis.
Melanosis.
Lobar pneumonia.
Infarcts.
Verminous pneumonia.
Pseudo-tuberculosis.
Actinomycosis.
Cysticercus tenuicollis.
,, bovis.
,, cellulosæ.
Stomach contents.
Empyema.
Emphysema.
Calcification.
Broncho-pneumonia.
Hæmorrhages.
Mycotic pneumonia.
Liver-fluke.
Echinococcus cysts.
Pleuro-pneumonia.
Swine fever.
Inspiration of blood.

(15) **Lymphatic Glands**

Tuberculosis.
Œdema.
Actinomycosis.
Anthrax.
Pentastomum larvæ (mesenteric).
Echinococci.
Sarcomata.
Carcinomata.
Swine fever.
Adenitis.
Cysticerci.

(16) **Nervous system**

Meningitis.
Œstridæ larvæ.
Neuromata.
Abscess.
Tuberculosis.
Cœnurus cerebralis.
Echinococci.
Cysticercus bovis.
,, cellulosæ.

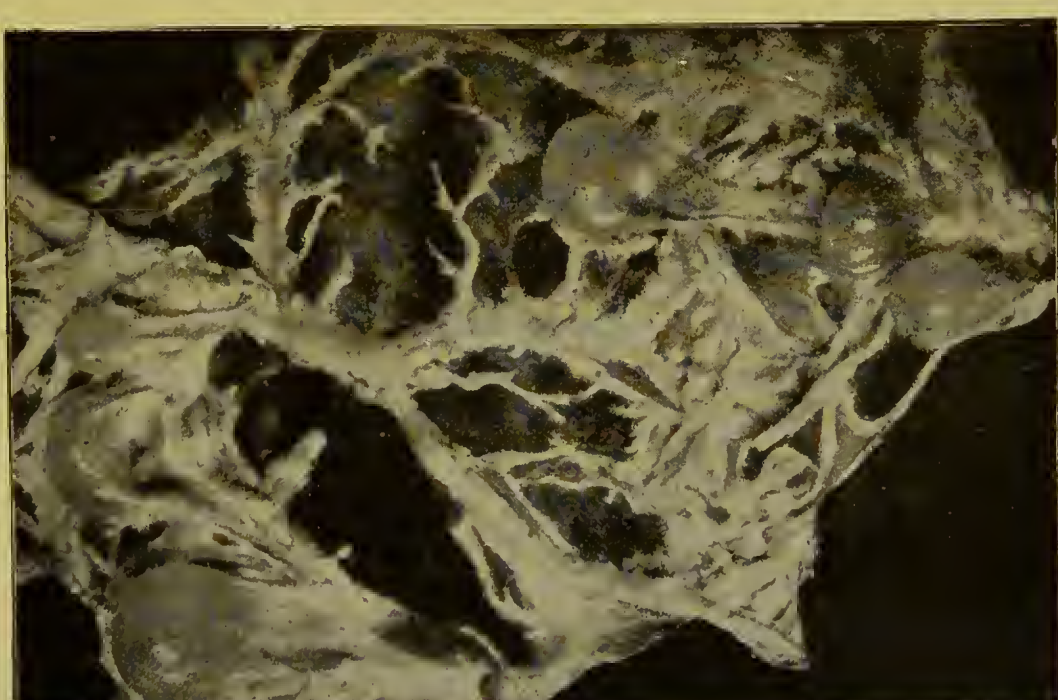


Fig. 29.—Cysts in Pig's Omentum

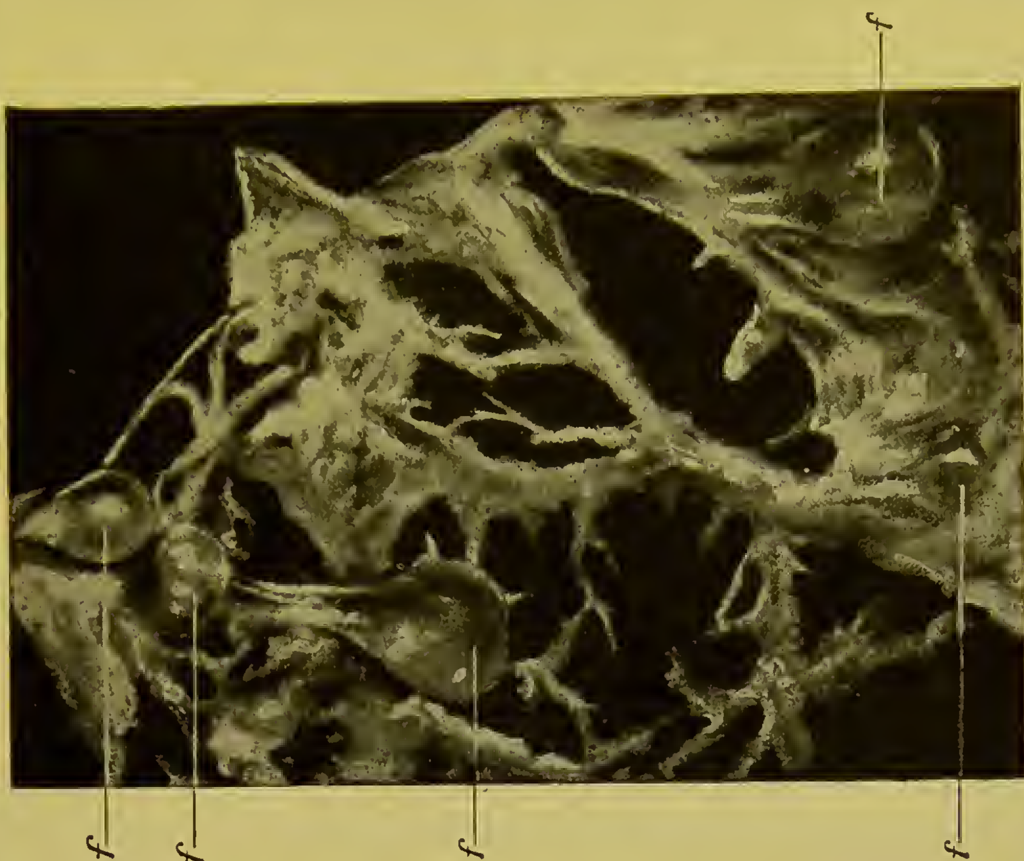


Fig. 30.—Cysts (Larval Tape-worm in Omentum
f. cyst.

(17) **Skeleton**

Rickets.	Osteomalacia.
Fractures.	Tuberculosis.
Actinomycosis.	Osteomyelitis.
Echinococci.	Arthritis.

(18) **Muscles**

Rupture.	Hæmorrhages.
Hyaline degeneration.	Myositis.
Tumours.	Actinomycosis.
Botriomycosis.	Cysticerci.
	Trichinosis.

SUGGESTED UNIFORM STANDARD SUMMARISED

In the absence of any legal uniform standard of inspection, excepting the recommendations of the Local Government Board for tuberculosis and the enactments dealing with anthrax, swine fever, and one or two other contagious diseases, we may now summarise the list of judgments which we have suggested in the former pages. We fully admit, of course, that in many cases we have still much information to gain which may subsequently modify present opinions ; but we are also of opinion that it will assist the meat inspector if he has some standard of uniformity set before him, to which, *pending further legal instructions*, he may conform. The following table then will be understood to be in the nature of a standard *suggested* to meet present knowledge and conditions in this country.

Summary of Judgments in Diseased Carcases

Disease.	Judgment.
Bovine tuberculosis	L.G.B. Recommendations.
Swine tuberculosis.	L.G.B. Recommendations.
Avian tuberculosis.	Condemnation of bird.
Tuberculosis of small mammals.	Condemnation.
Natural death ; fallen carcase ; found dead, from any cause.	Condemnation.
Immature carcases, within eight days at least from birth ; preferably two weeks for hogs, three for lambs, and four for calves.	Condemnation.
Any acute bacterial septicæmia (speaking generally).	Condemnation.
Pyæmia, especially in conjunction with presence of wounds.	Condemnation.
General dropsy.	Condemnation.

Great emaciation, from any cause.	Condemnation.
General jaundice.	Condemnation.
Pronounced abnormal odour.	Condemnation.

The following specific microbic infections should require the carcase to be withheld from sale as food :

Anthrax (burn or bury carcase) ; glanders ; swine fever ; swine erysipelas ; tetanus ; malignant œdema ; pneumonia (lobar).	Condemnation.
Multiple tumours, generalised sarcoma, or carcinoma (cancer).	Condemnation.
Cysticercosis, with œdematous or discoloured meat, and gelatinous fat.	Condemnation.
Trichinosis.	Condemnation.

In all the above the condemnation should be total, and of all cases septic conditions (*e.g.*, metritis) are the most dangerous.

Partial condemnation may be allowed in the following cases, where the disease is restricted to definite areas, or such parts of the body as admit of its ready excision, and the destruction of the affected part :

Actinomycosis. Botriomycosis. Parasites in viscera (*e.g.*, distomatosis of liver, cysts of T. echinococcus, &c.). Single non-malignant tumours. Inflammatory local swellings. Local wounds and fractures. Local putrefaction, traumatic. Bruised, discoloured areas.	Partial condemnation, *i.e.*, destruction of the affected part.
Lungs with stomach contents. Local diseases affecting the liver, lungs, kidneys, spleen, stomach, intestines, brain, heart, single muscles.	Condemnation of the affected organ.

In many diseased or morbid conditions it is perfectly possible to render the fat and flesh fit—as far as danger from infection is concerned—by special methods of treatment ; but as no provision is made in this country for thus dealing with condemned meat it is unnecessary to enter into details as to how this may be done. The time may come when it will be necessary to draw up regulations from this point of view.

In some of the above cases, and in some not mentioned, full provision is already made by law as to how the infected animals shall be dealt with. They need not be referred to further here.

Finally, in this connection, we repeat that uniformity in meat inspection is only to be satisfactorily attained by uniformity in the teaching of the subject for definite State requirements.

SWINE FEVER

A portion of intestine showing the diphtheritic type of lesion.

CHAPTER XVI

BACTERIOLOGY IN MEAT INSPECTION

Necessity for Bacteriological Training. That the modern scientific meat inspector must be at least a competent bacteriologist and microscopist goes without saying. It is not absolutely necessary, nor in any way essential, that he should be a laboratory expert, since the aid of such a person can always be obtained when necessary ; but it is quite necessary that he should have been trained by passing through an ordinary course of pathology and bacteriology, both theoretical and practical, involving experience in the use of the microscope and in the preparation of tissues and bacteria which may have to be examined. Such a course of instruction has to be passed through by every student at a veterinary college in the ordinary course of his career, and the meat inspector who has paid ordinary attention to his work as a student will by constant practice afterwards very quickly render himself thoroughly efficient in the examination and investigation of those processes with which he has almost exclusively to deal.

The growth of the science of bacteriology during the last twenty years has influenced the mode of thought of science in many and varied directions. Considering the deplorably inadequate provision for proper meat inspection in Great Britain during those years, it is not astonishing that in this sphere the influence of bacteriological progress should have been tardy in appearance. But we have to deal with things as we find them to-day, and it is not too much to say that unless those whose business it is to deal with the problems of meat inspection are thoroughly imbued with the spirit of the science of bacteriology, they must be hopelessly incompetent for their task. It is not a matter of merely being able to recognise several bacilli under the microscope, though that is important ; it is a matter of thoroughly appreciating *the nature of bacterial action on living tissues*, how bacteria live and move and multiply, how they produce their effects, how those effects manifest themselves in symptoms and organic changes, and how the effects can be neutralised. For, after all, what is the object of an efficient system of meat inspection ? Is it not to supply a means of thorough protection for the public from any danger of eating meat which may be the means of conveying disease or harm ? If so, we have only further to add that the great means by which disease is spread from one animal to another, whether the source be a living animal or a dead one, is living bacteria present in the carcase, or products for which those bacteria are responsible. Of all the diseases which account for the vast number of carcases condemned as unfit for

human consumption, those suffering from tuberculosis and septicæmic conditions of one kind or another constitute the vast majority. These are bacterial infectious diseases, and it is not enough that the meat inspector should be taught to recognise the gross lesions of tubercle, he must be so trained as to have an intelligent conception of what has taken place in the carcase so altered, and what would be likely to occur if meat of such a condition were exposed for sale as food. In a word, the greatest part of practical meat inspection is merely a special phase of practical applied bacteriology, since the majority of the important diseases from which the food animals suffer and which come under the notice of the inspector are bacterial in their origin. We say, then, once more that the modern meat inspector must be at least a competent bacteriologist.

It is unfortunately, however, only too true that no matter how good the workman may be he is helpless without his tools, and in no sphere of labour is this so obvious as in modern applied science.

Accommodation and Apparatus required. In order, then, that the meat inspector may be given a fair opportunity to do his work in a scientific manner, he must be supplied with the necessary accommodation in which to do it and the apparatus required. In most British slaughter-houses both these conditions are lacking. The inspector is given a merely routine task, and is almost encouraged to do it in an empirical manner. At least this has been the case until quite recently. There are signs, however, that a better appreciation of the problems involved is being attained by those in authority. It is to be hoped that the time is not far distant when every slaughterhouse, in our large cities at least, will have attached to it, as part of its equipment, a laboratory in which the inspectors will be expected and encouraged to verify their opinions by actual bacteriological methods, and to give a certain amount of their time to original investigations in connection with the more obscure conditions with which they have to deal. It is only in this way that accurate scientific knowledge on meat inspection can be advanced. It is the man on the spot who must do it, for it is his business alone or chiefly, and no one else has either time or opportunity.

Equipment Necessary. It will be as well to indicate briefly the equipment necessary for a small practical working department, lest the above remarks be met with the criticism that the fitting up of such a department would involve a cost quite beyond the means of corporations or other bodies under whose management slaughterhouses exist. In those cities in the kingdom in which there exists a veterinary college, or a university with a veterinary faculty, there ought to be but little difficulty in arranging for such a department, the expense of which may be borne partly by the teaching body and partly by the slaughterhouse authorities. This scheme is being already adopted in Edinburgh on the suggestion of the writer, where in the new slaughterhouses at present being erected a special meat-inspection department is being planned by those responsible for the slaughterhouses, while its equipment, on the other hand, falls

upon the Royal Veterinary College at Edinburgh. In other places where there is no veterinary centre of education a much less elaborate procedure would be amply satisfactory, and we would urge upon all authorities, especially at this time when so many old slaughterhouses are being replaced by up-to-date modern buildings, that in every case a small room or building be provided for the inspectors in which bacteriological work may be carried out.

The equipment of such a room or laboratory need be only of the simplest character provided that the room itself is thoroughly well lighted, both naturally and artificially, and provided with hot and cold water and gas. The other essentials are one or two benches and tables to work at, two good microscopes, one for ordinary work and a special oil-immersion apparatus for bacterial work, together with the usual apparatus for the cultivation of organisms. To mention these in detail so as to show how short the list really is, we may enumerate the following as meeting all requirements :

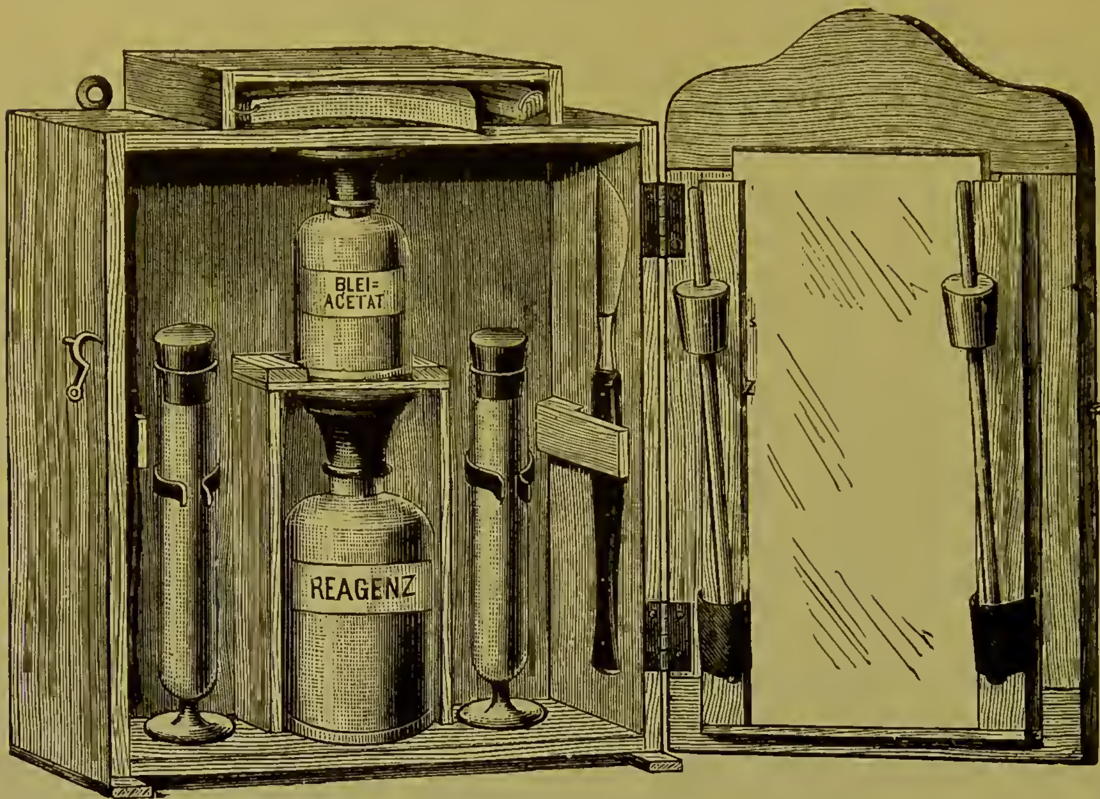
One ordinary microscope, high and low power.
One oil-immersion microscope.
One hot-air steriliser.
One steam steriliser.
A supply of nutritive media.
Petri dishes.
Freezing microtome.
Platinum needles.
Microscopic slides.
The various stains.
Antiseptics and a few chemicals.

The above list includes everything that is absolutely necessary for all ordinary, everyday work, and would, we venture to say, be heralded with delight by every meat inspector who found himself provided with the opportunities it gives. It could be added to indefinitely, according to how far the department worked in co-operation with the public health department of the city, but without any additions at all it is sufficient for the ordinary bacteriological purposes of modern scientific meat inspection.

Laboratory Outfit. As the fitting up, or at least the choice of apparatus for fitting up, may possibly fall to the lot of some readers of this work, it will be convenient to specify exactly what is required for a small and medium outfit. The small outfit will be sufficient where there is only one worker to use it or where accommodation is strictly limited, and the medium outfit where several inspectors or others work together and where the accommodation and space is on a somewhat more generous or elaborate scale. Of course, there is practically no limit to a bacteriological outfit if money and accommodation are no object, but as such a condition of affairs is one which in scientific work in this country is non-existent, it need not be considered. It will be more to the point,

and of more practical assistance, to keep a minimum rather than a maximum expenditure in view.

The following will be found sufficient to permit of a great deal of good work being done, without containing any superfluous items :

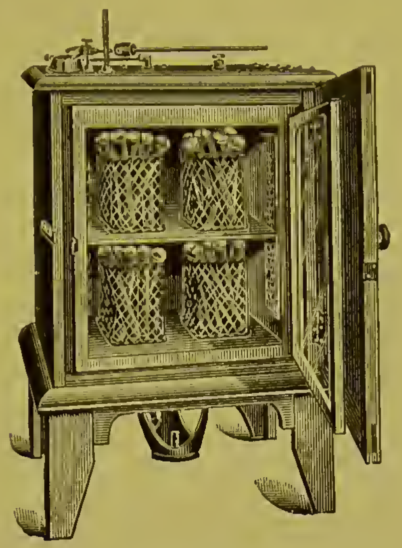


INSPECTOR'S TESTING CABINET (GERMAN)

ESTIMATE FOR SMALL BACTERIOLOGICAL OUTFIT

	£	s.	d.
Incubator, Edinburgh pattern, including gas-regulator, Bunsen, thermometer, and rubber tubing .	4	10	0
Hot-air steriliser with stand, with Bunsen and thermometer	1	18	0
Small steam steriliser and hot-water funnel, with Bunsen and rubber tube		16	0
Six pairs Petri's glass dishes		4	9
Half gross test-tubes		3	3
Funnels, flasks, and pipettes.		7	0
Filter-paper and test-tube racks		6	0
Peptone, gelatine, and agar-agar		5	0
	£8	10	0

The larger equipment will be directed partially to supplying an incubator of greater dimensions, and thus allowing of more work being done at once, and, secondly, supplying a larger steam steriliser, which is a matter of considerable importance where there is much to do. The

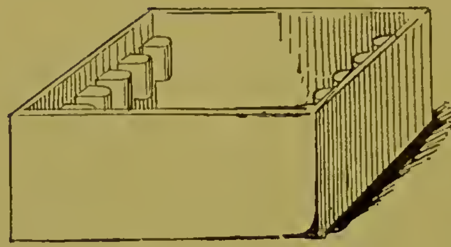


INCUBATOR

other items, in order to allow of more workers being considered, may be roughly doubled in quantity. This would give an equipment the cost of which would work out somewhat as follows

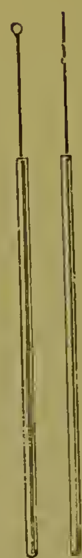
INCUBATOR

Stand for Reagents

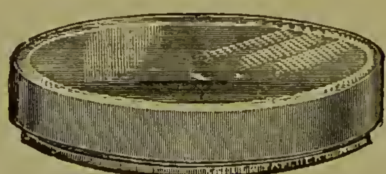


Bath for Slides

Bacteriological Cabinet



Platinum Needles



Petri Dish

VARIOUS LABORATORY APPARATUS

Estimate for Medium Bacteriological Outfit

	£	s.	d.
Incubator, Hearson's pattern A1, inside sizes, 12 × 12 × 14	7	3	0
Hot-air steriliser and stand, with Bunsen and thermometer	1	18	0
Steam steriliser, with Bunsen burner and thermometer	1	14	0
Hot-water funnel, 6 in. diameter, double-walled .		16	0
One gross test-tubes		7	6
Funnels, flasks, pipettes, &c.		15	0
Filter-paper, test-tube racks, &c..		10	0
Peptone, gelatine, and agar-agar		10	0
Slides, cover glasses, stains, &c.		12	6
Twelve-feet rubber tube for incubator and sterilisers		4	6
	£14	10	6

The above figures, which are those of actual prices which we have verified, will be seen to refer to the *initial* cost of outfit. Certain items, such as the media, slides, stains, &c., will fall to be replaced as they are used up, but the apparatus itself will last a very long time if due care and attention be devoted to it.

The Microscope. A good microscope is the most essential thing in the bacteriological outfit, and while there is no limit to the luxury obtainable in this instrument if funds permit, it is perfectly possible at the same time to obtain a thoroughly serviceable instrument at a comparatively small cost. Most instrument-makers and opticians, both British and foreign, have a suitable microscope for ordinary purposes. The one we illustrate here is that which we ourselves usually advise for our own students, having found it an excellent and reliable instrument.

Description of the Microscope. The principles employed are, briefly, as follows : The foot and pillar are cast in one piece and the stage and limb are made in a similar manner. These two parts are connected together by a strong axis joint, thus dispensing with the screws and bolts that are usually employed. The result is an instrument which is firmly and solidly framed, and which is free from any suspicion of spring or vibration in its parts. These stands are highly recommended for purposes where a microscope is liable to receive rough usage, and for laboratory use, students' use, and travelling. For experimental work where use is made of acids, &c., they are unrivalled.

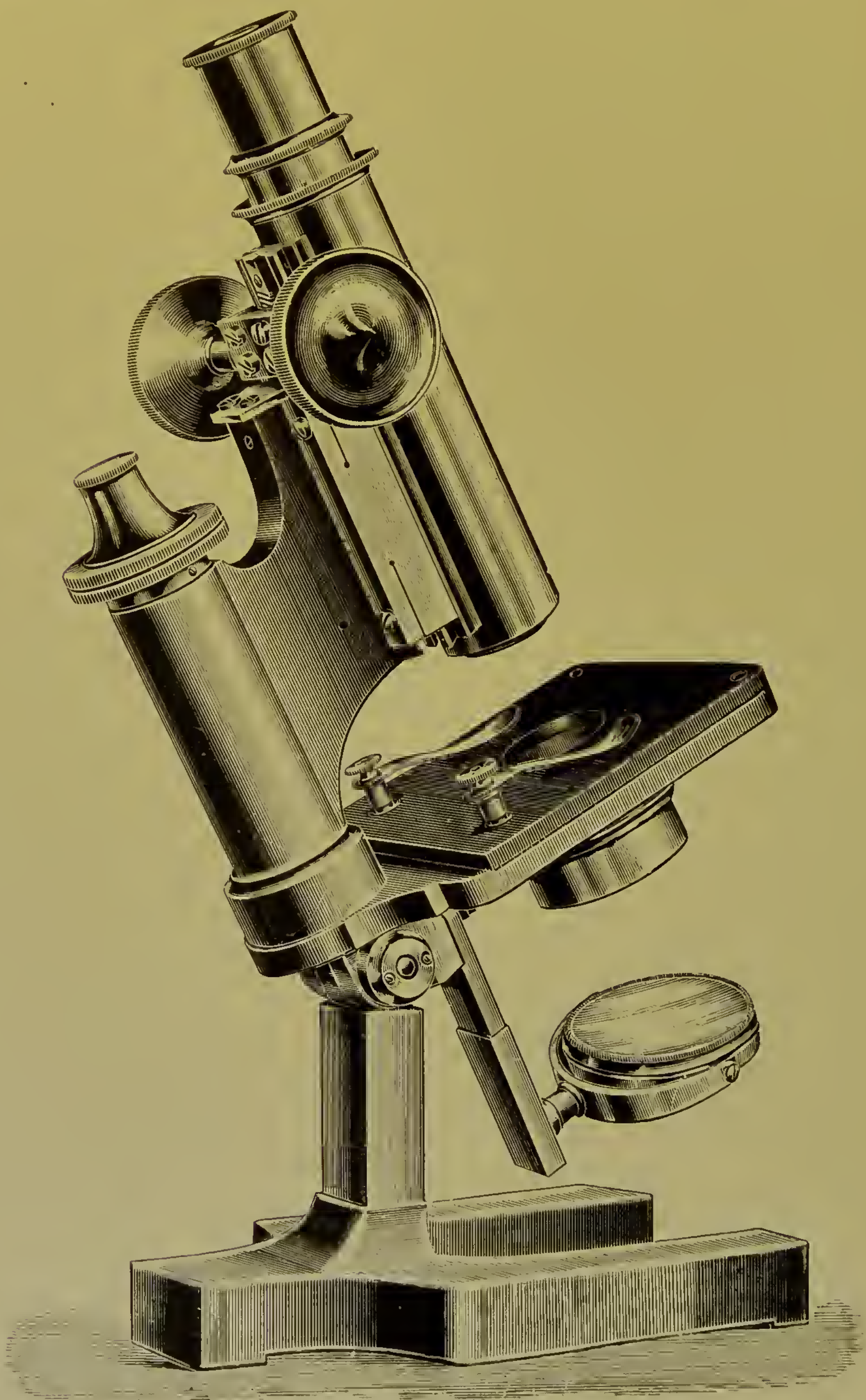
The "Praxis" is eminently suited to the requirements of those who need a simple stand without costly mechanical refinements for everyday work.

These patterns are extremely portable, being compact in build, and may be conveniently carried without fatigue. At the same time the

parts are all of standard (R.M.S.) size, and the horse-shoe foot is formed so as to support the microscope steadily in any position. These microscopes are "cheap" in the true sense, inasmuch as they will last for years without getting out of order.

Specification. Coarse and fine adjustments of standard patterns.

The body length when closed is 145 mm. ($5\frac{1}{16}$ in.) long; and when the draw-tube is extended, 225 mm. long. With a revolving nose-piece in



TYPE OF MICROSCOPE FOR INSPECTORS

position, the total length would be approximately the full English length. It carries eye-pieces of the standard continental or student's size.

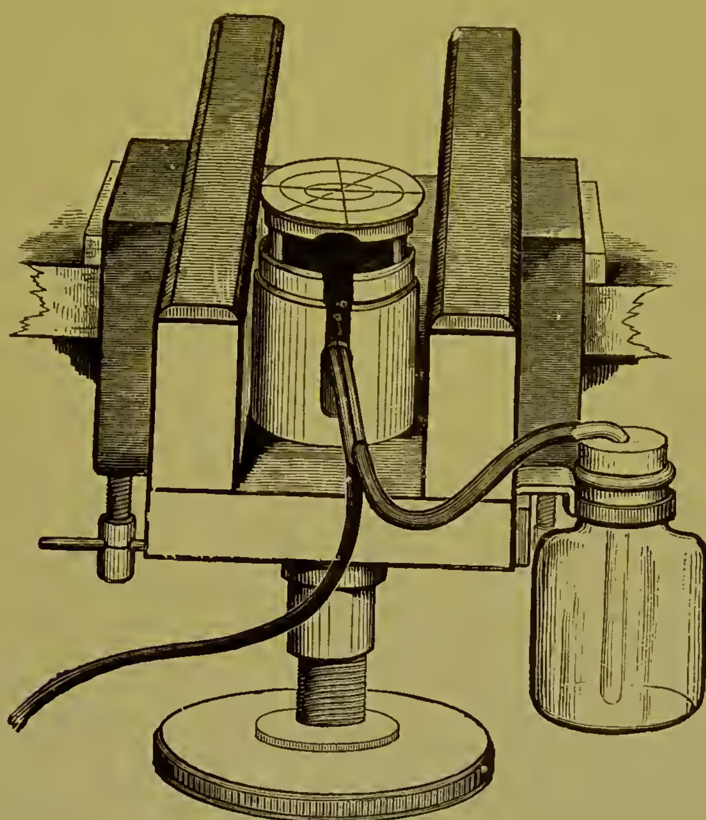
The stage, which is covered with ebonite, is $3\frac{1}{2}$ in. square. There is ample room for Petri's dishes, &c., the distance from the front of the limb to the centre of the stage being $2\frac{1}{4}$ in.

The fitting for condenser, &c., turns aside from the optical axis.

The mirrors are plane and concave.

The instrument is inclinable to the horizontal.

The Microtome. For detailed examination of organs and solid tissues, some form of apparatus by means of which a section may be cut is neces-



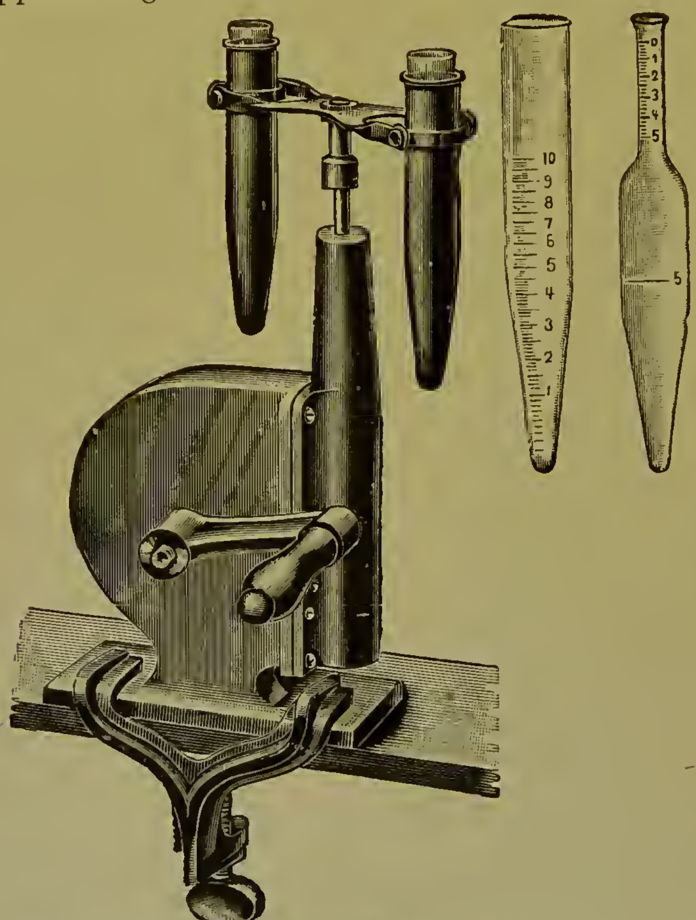
FREEZING MICROTOME

sary, and for ordinary diagnostic work, which has to be rapidly performed at a moment's notice, probably nothing better can be recommended than the ordinary Cathcart Microtome here illustrated. It can be used either for freezing or embedding, but it is the former operation that we are now concerned with. The illustration shows this microtome arranged for freezing. Ether is placed in the small bottle and applied to the under surface of the microtome by squeezing an indiarubber bellows with the hand. The mass of tissue to be cut, which should not measure more than half an inch each way on the surface nor more than one-quarter of an inch in thickness, is placed on the microtome and covered with a freezing medium, and the ether immediately applied.

A good deal of the comfort and satisfaction obtained in working this microtome depend on having a freezing mixture which always behaves

in a uniform manner and which can be depended upon. Various recipes are recommended by different workers, but we can confidently recommend that given at the end of this section, especially where the work has to be done under conditions which are not always of the most elaborate and luxurious nature (p. 1088).

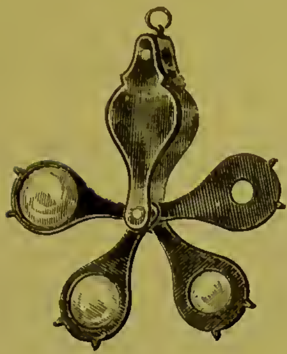
Every machine has its advantages and disadvantages, and this one is no exception. Its advantages are its relative cheapness (the whole thing need only cost a guinea, complete) and its simplicity, there being no complicated parts to get out of order. Its greatest disadvantage, in our experience, is the tendency of the indiarubber spray bellows to become faulty and leak, requiring somewhat constant repairing. The mending is, however, a very simple matter. A good point, too, is that any ordinary razor can be used for cutting, provided it is in good condition. Of course, there are many more elaborate and expensive microtomes to be had, and those who are in a position to provide them will find ample choice in the lists of all the well-known makers of bacteriological and pathological apparatus. We are here thinking not so much of the equipment of a university laboratory as the needs of the meat inspector at a well-equipped slaughterhouse.



CENTRIFUGAL MACHINE FOR URINE, WATER, SPUTUM, MILK, AND BLOOD TESTS

Centrifuge of cast-iron, as figured, with aluminium holders for two test-tubes, screw clamp for bench, and one each plain and graduated 15 ccm. tubes.

Speed about 2000 to 3000 revolutions per minute.



POCKET MAGNIFIERS

Centrifugal Machines. Fluids as well as solid tissues constantly call for examination, whether they be urine, water, sputum, milk, blood, pus, or effusions. A simple centrifugaliser will be found almost essential and certainly of the very greatest assistance. A machine such as that illustrated will answer every ordinary purpose and costs only about thirty shillings or so. The centrifuge is made of cast-iron, as figured, with aluminium holders for two test-tubes, a screw clamp to fix the centrifuge to a bench or table, and two fifteen-cubic-centimetre tubes, one of which is plain and the other graduated, as shown. The speed attained is from 2000 to 3000 revolutions per minute.

Pocket Magnifying-glasses. Although not strictly connected with bacteriology, we may here conveniently draw attention to the advisability of the meat inspector providing himself with a good pocket magnifying-glass. This simple aid to accurate diagnosis is not used nearly so much as its value deserves. Many small lesions on the surface of organs, which are just doubtful when viewed by the naked eye, become clear when slightly magnified, and many parasites can readily be recognised by similar means. The precise form of the magnifier is of comparatively little importance ; each may follow his own taste in the matter, provided that on trying the lens it is found to answer its purpose. The most common forms are shown in the illustrations above.

Having thus indicated what in our opinion should constitute the minimum equipment of the meat-inspection department in an up-to-date slaughterhouse, we now pass on to the consideration of the bacteriology of meat inspection itself. Before doing so, however, let us say at once it is presumed in what follows that the meat inspector has had the ordinary training in practical pathology and bacteriology which the modern veterinary surgeon receives, and that he possesses at least one of the many excellent text-books on bacteriology which exist. It is no part of our purpose here to give a systematic account of bacteriology ; we desire to treat it only from the point of view of the meat inspector, leaving him to refer to his systematic text-books as required. All that we shall do is to describe, briefly and simply, the actual procedures which he himself will be called upon to undertake, and to describe the various organisms which alone are of importance in his special sphere. The general science of bacteriology, the one hundred and one other procedures

in that science and the vast number of other microbes with which it deals, have nothing to do with us here and consequently find no place in what follows. The inspector should provide himself with one good text-book for purposes of general reference, and for this object he cannot do better than obtain Muir and Ritchie's "Manual of Bacteriology," which work is the authority for many of the statements which follow.

PRACTICAL HINTS FOR WORKING IN THE LABORATORY

The Danger to the Worker. There is, perhaps, no kind of work more attended with the danger to which familiarity breeds contempt than that of the bacteriologist. No matter how carefully he has been trained and taught, unless he gets into a routine system of working, he is very apt to run many unnecessary risks in dealing with dangerous microbes; hence every now and again occur those sad cases of death from accidental inoculation and infection, many of which might easily be avoided if ordinary care were always taken. Bacterial cultures and drops of fluid look extremely innocent things, but it cannot be too strongly insisted upon that every bacteriological investigation should be treated as a possible source of danger until its harmlessness has been clearly established.

Sterilising Agents and Apparatus. The first essential in the working-room where such investigations are carried out is a plentiful supply of reliable sterilising solution, by far the most reliable of which is a solution 1 in 1000 of mercuric chloride (corrosive sublimate) in water. A basin containing a sufficient quantity of this should always stand upon the working-bench of the bacteriologist, so that his hands, as well as certain kinds of apparatus, can be plunged into it at a moment's notice. It must be remembered that metallic instruments are injured by the action of this solution, which, however, can be used for test-tubes, old cultures, and infected tissues, to render them antiseptic. Great care should be taken not to allow infected organs or suspected material to be left about the laboratory any longer than is absolutely necessary. Apart from the immediate danger, it must also be remembered that putrefactive processes rapidly set in, and every microbe which is allowed to remain in the room renders the work of the bacteriologist more difficult in his subsequent investigations. Pure cultures are rendered more difficult to obtain, and the sources of contamination are needlessly multiplied. The vessel containing the antiseptic solution should be repeatedly cleaned out and further solution added. All apparatus sterilised in corrosive sublimate will require careful washing under the tap to remove the antiseptic if such apparatus is required for purposes of culture. It will be as well to have two distinct vessels containing the antiseptic solution, one of which should be retained exclusively for the hands of the worker. We would impress upon our readers the importance of *getting into the habit* of sterilising the hands before beginning to handle any suspected material, and repeating the process once or twice during the work, as

well as on the completion of the task, after which the hands and forearms should be well washed with soap and water. Old cultures containing pathogenic microbes no longer required should be thoroughly sterilised in the steam steriliser, from two to three hours before the tubes are washed out.

General Precautions. On no account should any food be partaken of in the bacteriology room, nor should it be allowed to come into that room at all. Great care should be taken lest cigarettes or pipes become contaminated by being allowed to rest on a bench where work has been, or is being, done. In affixing labels to specimens or parcels, and in fixing stamps, moisture should be applied either by a brush or the finger-tip in water, and never under any circumstances by licking with the tongue. In the event of any slight cut or prick being sustained, the operator should immediately sterilise his hands by thoroughly soaking them in corrosive sublimate solution for some minutes. The floor of the room should consist of such material as will allow of strong antiseptic solutions being applied to it from time to time, since it is almost impossible to prevent drops of infective fluid or portions of tissues coming in contact with the floor now and then.

Growing of Cultures. Cultures grown on ordinary nutrient gelatine will usually be kept in a rack upon a shelf at the ordinary room temperature during most of the months of the year. It will be remembered that this medium as usually prepared melts at a temperature of about 22° Cent., the usual room temperature varying from about 12° to 18° Cent.

Should the climatic conditions, especially in winter, render it difficult to cultivate microbes on a gelatine medium, advantage may be taken of an incubator specially made for this purpose possessing a low-temperature regulator which keeps the thermometer at about 21° Cent. These are called cool incubators.

In the case of those organisms which require to be grown at or about the temperature of the blood or the body of those animals from which they are obtained, it will be necessary to use the nutritive media stiffened by the addition of agar instead of gelatine, the cultures being placed in an ordinary incubator with the temperature at about 37° Cent. There are many varieties of these incubators in the market, the best of which, in our opinion, are those of Messrs. Hearson, of London. A practical point worth remembering is that in such incubators where the temperature is high there is apt to be considerable evaporation from the surface of the culture which may cause the latter to dry up, and this can readily be obviated by placing a small dish of water in the bottom of the incubator to maintain the necessary amount of moisture in the air within.

Making Pure Cultures. The most convenient tubes for cultures are those of the size of 6 × 5 in. These must be thoroughly cleaned and sterilised before the media are introduced, but unless the bacteriological work is on a very large scale it will be found more satisfactory to purchase them from the nearest maker in quantities of, perhaps, one or two dozen

at a time. In this way the possible disappointments in making the media are avoided and the uniform culture medium assured. The contents of the tubes can be readily made into "slopes" or other shapes by simply standing the tubes in warm water and allowing the medium to reset in any position required.

Separation of Microbes. In order to ascertain what organisms are present in a piece of suspected meat or in a portion of fluid or other material from which an investigation is required, the simplest and most convenient method of procedure will probably be found to be the following. Suppose that it is required to ascertain the bacterial contents of some suspected fluid from a carcase. Proceed to carry out what is known as the "three-tube method." Inoculate a tube of gelatine marked A, the medium in which has been melted by allowing the tube to stand in warm water, with one or two drops of the suspected fluid, by means of a platinum needle with a loop at the end. Thoroughly mix the contents of the tube. *From this* inoculate the second tube marked B, and similarly *from tube B* inoculate tube C. By this process the number of organisms present in the three tubes is progressively diminished. The inoculation of the three tubes must be done as nearly as possible simultaneously. Next take a sterilised Petri dish and carefully pour the contents of tube C into it, allowing the gelatine to solidify. If desired, the contents of tubes A and B can be similarly transferred to other Petri dishes, care being taken to label them A and B respectively. We may here point out that in the marking of glass tubes it is extremely convenient to use the coloured oil pencils specially manufactured for this purpose by Faber. In the above procedure, if the same number of loops of material be inoculated into each test-tube it will be observed that the result is a definite mathematical proportion in each case. If a preliminary microscopic examination has been made of the fluid under investigation, some idea may be gained as to the amount of dilution required in the process of isolating. Thus, if the fluid was crowded with organisms, a very small quantity should be taken for the first tube and, if necessary, the diluting process may be carried further by using a fourth tube, D, inoculated from C. This can be carried on *ad libitum.*

The Petri dishes are then allowed to remain for a day or two, being examined at intervals for the appearance of the bacterial colonies, and these may be picked off as they become large enough with the point of a platinum needle and transferred to separate test-tubes. The result is a number of pure cultures which have been isolated from the mixed bacterial infected substance. Similarly in the case of a piece of solid matter, such as a portion of suspected meat. A small piece of this should be introduced into tube A and thoroughly shaken up so as to allow the microbes present to distribute themselves as far as possible throughout the medium. Tubes B and C should then be inoculated as before and the procedure carried out as above described. In every case care should be taken to sterilise the platinum needle in a Bunsen burner between each stage of the process.

Making Film Preparations. The most convenient method for our purpose for the examination of fluids suspected of containing microbes is that known as the dry-film preparation. Such films can be made either on ordinary microscopic slides or on cover-glasses, the former of which is possibly the more convenient. We will, however, briefly describe both methods, as some prefer using one and some the other.

To make a dry-film preparation upon a slide (a method very useful, especially when the fluid to be examined is blood), it is essential that the microscopic slides must be absolutely clean. Moreover, since the slide may be wanted at a moment's notice, to examine, for example, the blood of a suspected anthrax case, it is well that the slides should be cleaned in bulk and stored in such a way that they can be used immediately. For this purpose they should be washed with a weak solution of caustic potash, then in water, and stored in a jar containing alcohol. When required for use the slide can be withdrawn from the alcohol and the latter set alight, the slide being immediately ready. If the fluid to be examined be blood, a drop is placed upon one end of the slide and the edge of a second slide is brought in contact with the first through the drop of blood already present. By holding this second slide at a varying angle the blood spreads itself along the edge of the second slide, which is then drawn over the surface of the first. It will be seen that by varying the angle at which the two slides are held the thinness of the film so made can be regulated. A considerable surface of film can thus be made, covering indeed almost the whole slide, which is then allowed to dry, and the result is a dry-film preparation. Such a preparation can be stained by any of the methods to be afterwards described.

Instead of using a microscopic slide, a cover-glass may be substituted, this being particularly convenient for the examination of cultures as well as drops of fluid. Here, as in the case of the slide, the cover-glass must be first perfectly cleaned. This is best done by placing the cover-glasses in a mixture consisting of sulphuric acid six parts, potassium bichromate six parts, and water one hundred parts. The cover-glasses should be allowed to remain in this for some time. They are then washed thoroughly well in water and kept ready for use in a small vessel containing absolute alcohol as in the case of the slides. To make the film preparation, a small drop of the fluid to be examined should be placed upon the cover-glass either by a platinum needle with a loop or by a glass rod, and the drop of fluid spread over the surface of the cover-glass. This may be done either by the needle or by another cover-glass placed on the first and the two then separated. The advantage of this latter proceeding is that two film preparations can be made at one and the same time. If the material for examination be solid or a portion of pure culture, the only difference in the procedure is that a drop of distilled water is first placed upon the cover-glass and then a very minute portion of the material or culture thoroughly mixed in this drop so as to spread over the cover-glass in the thinnest possible manner. It is almost impossible in dealing with a pure culture to take too little for this purpose. If too

much be taken, which almost invariably happens with the beginner, it is found on examination under the microscope that the organisms are not sufficiently spread out or separated from each other so as to enable individual microbes to be examined. The film must next be dried, which is best done by moving it backwards and forwards at a little distance from the flame of a Bunsen burner or a spirit-lamp. When thoroughly dried and the cover-glass passed once or twice through the flame, the organisms are fixed on the glass. The heat required for this last procedure is best judged by the operator noticing that the fingers in which the cover-glass is held are not burnt.

In examining a drop of blood in this way, it is quite sufficient to place a single drop on the one cover-glass, covering this by a second, drawing the two apart and allowing them to dry in the air. In the case of purulent fluids a drop may be spread out over the cover-glass with the platinum needle. Similar preparations may be made from solid tissues containing exudates or secretions. Thus a portion of lung-tissue may be held between the fingers or a pair of forceps and smeared over the surface of a cover-glass or slide and dried in the same way for purposes of bacteriological examination.

The dry-film preparation, having been made, requires to be stained, washed in water, dried and then mounted in xylol balsam.

The Staining of Bacteria. "It is most convenient to keep saturated alcoholic solutions of the stains made up, and for use to filter a little into about ten times its bulk of distilled water in a watch-glass. A solution of good body is thus obtained. Many bacteria (except those of tubercle and a few others) will stain in a short time in such a fluid. Watery solutions may also be made up, *e.g.*, a saturated watery solution of methylene-blue or a 1 per cent. solution of gentian-violet. Stains must always be filtered before use ; otherwise there may be deposited on the preparation granules which it is impossible to wash off. The violet stains in solution in water have a great tendency to decompose. Only small quantities should, therefore, be prepared at a time."

The Staining of Cover-glass Films. "Films are made from cultures as described above. The cover-glass may be floated on the surface of the stain in a watch-glass, or the cover-glass held in forceps with film-side uppermost may have as much stain poured on it as it will hold. When the preparation has been exposed for the requisite time, usually a few minutes, it is well washed in tap-water in a bowl, or in distilled water. When the film has been washed the surplus of water is drawn off with a piece of filter-paper, the preparation is carefully dried high over a flame, a drop of xylol balsam is applied and the cover-glass mounted on a slide. It is sometimes advantageous to examine films in a drop of water in place of balsam. The films can be subsequently dried and mounted permanently. In the case of tubercle, special stains are necessary, but with this exception practically all bacterial films made from cultures can be stained in this way. Some bacteria take up the stains rather slowly, and for these the more intensive stains, red or violet, are to be preferred.

"Films of fluids from the body (blood, pus, &c.) can generally be stained in the same way, and this is often quite sufficient for diagnostic purposes. The blue dyes are here preferable, as they do not readily overstain. In the case of such fluids, if the histological elements also claim attention, it is best first to stain the cellular protoplasm with a 1 to 2 per cent. watery solution of eosin (which is an acid dye), and then to use a blue which will stain the bacteria and the nuclei of the cells. The Romanowsky stains are here most useful, as by these the preparations are fixed as well as stained. Fixation by heat, which is apt to injure delicate cellular structures, is thus avoided. In the case of films made from urine, where there is little or no albuminous matter present, the bacteria may be imperfectly fixed on the slide, and are thus apt to be washed off. In such a case it is well to modify the staining method. A drop of stain is placed on a slide, and the cover-glass, film-side down, lowered upon it. After the lapse of the time necessary for staining, a drop of water is placed at one side of the cover-glass and a little piece of filter-paper at the other side. The result is that the stain is sucked out by the filter-paper. By adding fresh drops of water and using fresh pieces of filter-paper, the specimen is washed without any violent application of water, and the bacteria are not displaced.

"For the general staining of films a saturated watery solution of methylene-blue will be found to be the best stain to commence with, the Gram method (*vide infra*) is then applied, and subsequently any special stains which may appear advisable."

The Use of Mordants and Decolorising Agents. "In films of blood and pus, and still more so in sections of tissues, if the above methods are used the tissue elements may be stained to such an extent as to quite obscure the bacteria. Hence many methods have been devised in which the general principle may be said to be (*a*) the use of substances which, while increasing the staining power, tend to fix the stain in the bacteria, and (*b*) the subsequent treatment by substances which decolorise the overstained tissues to a greater or less extent, while they leave the bacteria coloured. The staining capacity of a solution may be increased :

"(*a*) By the addition of substances such as carbolic acid, aniline oil or metallic salts.

"(*b*) By the addition of alkalies, such as caustic potash of ammonium carbonate, in weak solution.

"(*c*) By the employment of heat.

"(*d*) By long duration of the staining process.

"As decolorising agents we use chiefly mineral acids (hydrochloric, nitric, sulphuric), vegetable acids (especially acetic acid), alcohol (either methylated spirit or absolute alcohol) or a combination of spirit and acid, *e.g.*, methylated spirit with a drop or two of hydrochloric acid added ; also various oils, *e.g.*, aniline, cloves, &c. In most cases about thirty drops of acetic acid in a bowl of water will be sufficient to remove the excess of stain from over-stained films and sections. More of the acid may, of course, be added if necessary.

"Hot water also decolorises to a certain extent; over-stained films can be readily decolorised by placing a drop of water on the film and heating gently over a flame.

"When preparations have been sufficiently decolorised by an acid, they should be well washed in tap-water, or in distilled water with a little lithium carbonate added.

"The methods embracing the use of a stain with a mordant and a decoloriser are very numerous, and we can only enumerate the best of them.

"Different organisms take up and retain the stains with various degrees of intensity, and thus duration of staining and decolorising must be modified accordingly. We sometimes have to deal with bacteria which show a special tendency to be decolorised. This tendency can be obviated by adding a little of the stain to the alcohol, or aniline oil, employed in dehydration. In the latter case little of the stain is rubbed down in the oil. The mixture is allowed to stand. After a little time a clear layer forms on the top with stain in solution, and this can be drawn off with a pipette.

"When methylene-blue, methyl-violet, or gentian-violet are used, the stain can, after the proper degree of decolorisation has been reached, be fixed in the tissues by treating for a minute with ammonium molybdate (2½ per cent. in water). The following are the formulæ of some of the more commonly used stain combinations:

"(1) *Loffler's Methylene-blue*

Saturated solution of methylene-blue in alcohol .	30 c.c.
Solution of potassium hydrate in distilled water (1–10,000)	100 ,,

"(This dilute solution may be conveniently made by adding 1 c.c. of a 1 per cent. solution to 99 c.c. of water.)

"Sections may be stained in this mixture for from a quarter of an hour to several hours. They do not readily overstain. The tissue containing the bacteria is then decolorised, if necessary, with ½–1 per cent. acetic acid, till it is a pale blue-green. The section is washed in water, rapidly dehydrated with alcohol or aniline oil, cleared in xylol and mounted.

"The tissue may be contrast-stained with eosin. If this is desired, after decolorisation, wash with water, place for a few seconds in 1 per cent. solution of eosin in absolute alcohol, rapidly complete dehydration with pure absolute alcohol and proceed as before.

"Films may be stained with Loffler's blue by five minutes' exposure or longer in the cold. They usually do not require decolorisation, as the tissue elements are not overstained.

"(2) *Kuhne's Methylene-blue*

Methylene-blue	1.5 gr.
Absolute alcohol	10 c.c.
Carbolic acid solution (1.20)	100 ,,

Stain and decolorise as with Löffler's blue, or decolorise with very weak hydrochloric acid (a few drops in a bowl of water)."

Gram's Method and its Modifications. " In the methods already described, the tissues, and more especially the nuclei, retain some stain when decolorisation has reached the point to which it can safely go without the bacteria themselves being affected. In the method of Gram, now to be detailed, this does not occur, for the stain can here be removed completely from the ordinary tissues, and left only in the bacteria. All kinds of bacteria, however, do not retain the stain in this method, and therefore in the systematic description of any species it is customary to state whether it is, or is not, stained by Gram's method—by this is meant, as will be understood from what has been said, *whether the particular organism retains the colour after the latter has been completely removed from the tissues*. It must, however, be remarked that some tissue elements may retain the stain as firmly as any bacteria, *e.g.*, keratinised epithelium, calcified particles, the granules of mast cells, and sometimes altered red blood-corpuscles, &c.

" In Gram's method the essential feature is the treating of the tissue, after staining, with a solution of iodine. This solution is spoken of as Gram's solution, and has the following composition :

" Iodine	1 part
Potassium iodide	2 parts
Distilled water	300 ,,

" The following is the method :

" (1) Stain in aniline oil gentian-violet or in carbol-gentian-violet (*vide supra*) for about five minutes, and wash in water.

" (2) Treat the section or film with Gram's solution till its colour becomes a purplish black—generally about half a minute or a minute is sufficient for the action to take place.

" (3) Decolorise with absolute alcohol or methylated spirit till the colour has almost entirely disappeared, the tissues having only a faint violet tint.

" (4) Dehydrate completely, clear with xylol and mount. In the case of film preparations, the specimen is simply washed in water, dried and mounted.

" In stage 3 the process of decolorisation is more satisfactorily performed by using clove oil after sufficient dehydration with alcohol, the clove oil afterwards being removed by xylol.

" As a contrast stain for the tissues, carmalum or lithia carmine is used before staining with gentian-violet (1). As a contrast stain for other bacteria which are decolorised by Gram's method, carbol-fuchsin diluted with ten volumes of water or a saturated watery solution of Bismarck-brown may be used before stage 4.

" The following modifications of Gram's method may be given :

" (1) *Weigert's Modification.* The contrast-staining of the tissues and stages (1) and (2) are performed as above.

"(3) After using the iodine solution, the preparation is dried by blotting and then decolorised by aniline-xylol (aniline oil 2, xylol 1).

"(4) Wash well in xylol and mount in xylol balsam. Film preparations, after being washed in xylol, may be dried, and, thereafter, dilute carbol-fuchsin may be used to stain bacteria which have been decolorised.

"This modification probably gives the most uniformly successful results.

"(2) *Nicolle's Modification.* Carbol-gentian-violet is used as the stain. Treatment with iodine is carried out as above and decolorisation is effected with a mixture of acetone (1 part) and alcohol (2 parts).

"(3) *Kuhne's Modification.* (1) Stain for five minutes in a solution made up of equal parts of saturated alcoholic solution of crystal-violet ('Krystall-violet') and 1 per cent. solution of ammonium carbonate.

"(2) Wash in water.

"(3) Place for two to three minutes in Gram's iodine solution, or in the following modification by Kuhne :

"Iodine	2 parts.
Potassium iodide	4 ,,
Distilled water	100 ,,

For use, dilute with water to make a sherry-coloured solution.

"(4) Wash in water.

"(5) Decolorise in a saturated alcoholic solution of fluorescein (a saturated solution in methylated spirit does equally well).

"(6) Dehydrate, clear, and mount.

"There is great variability in the avidity with which organisms stained by Gram retain the dye when washed with alcohol, and sometimes difficulty is experienced in saying whether an organism does or does not stain by this method" ("Manual of Bacteriology," Muir and Ritchie).

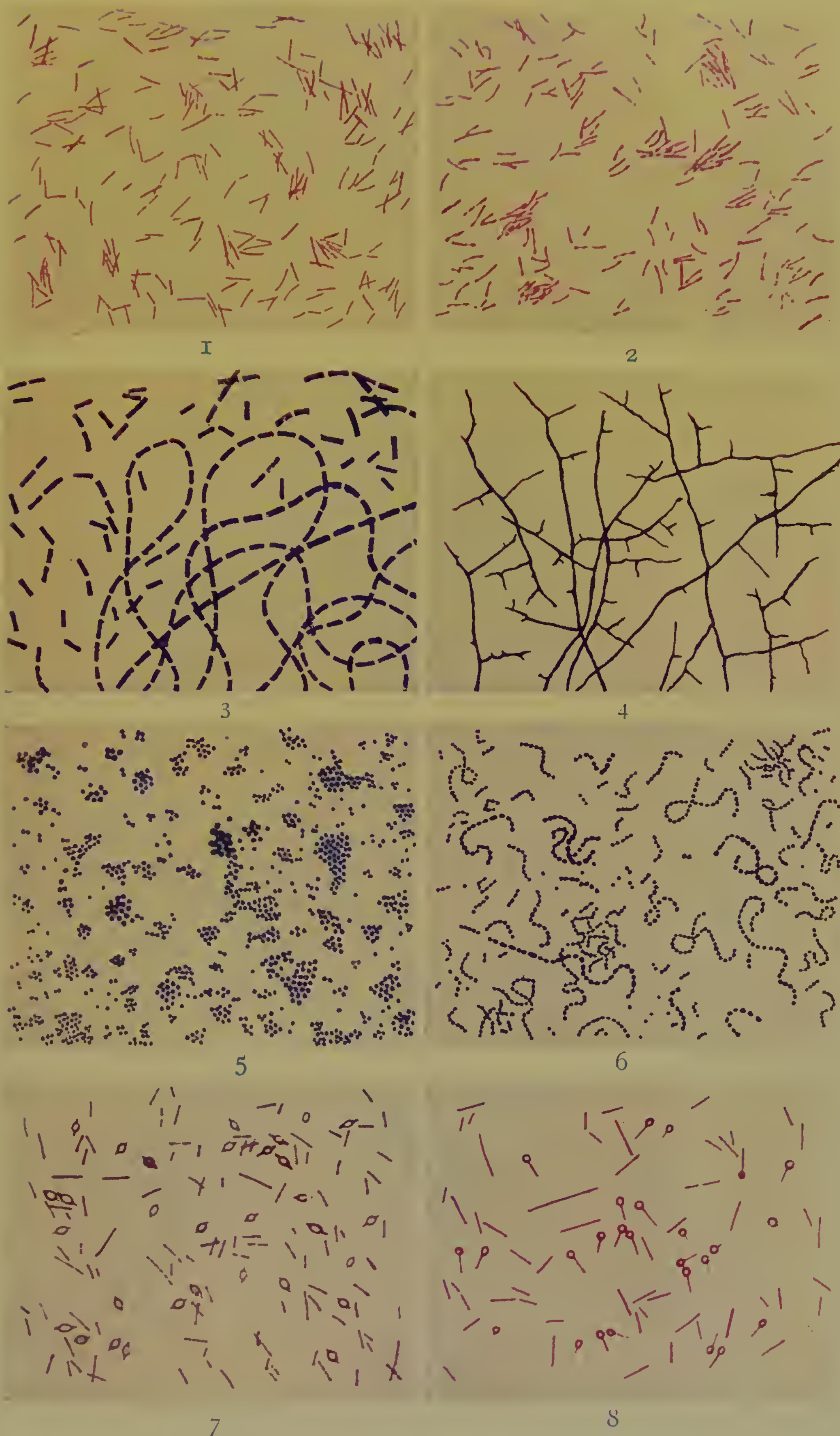
ROUTINE EXAMINATION FOR BACTERIA

We may suppose now that the inspector has at his disposal the various apparatus which we have mentioned, and is familiar with all the procedures necessary to undertake a bacteriological examination, and at this point it may be well to briefly summarise the line which his inquiry should take, indicating exactly the points upon which information is desired, so that, if necessary, he will be in a position to furnish a complete report upon the work. What he has to determine is the presence or absence of bacteria generally, or the presence or absence of some special microbe whose presence is suspected, so that his investigation must follow along two lines, the first being microscopic and the second purely bacteriological. In this connection the inspector will frequently have the advantage of being able to get his material at first hand, thus avoiding many difficulties and disappointments which arise from the extreme carelessness so often encountered at the hands of those who send specimens to laboratories for reports. The inspector can take his material at the moment he

VARIOUS PATHOGENIC MICROBES

As seen under the Microscope, stained

1. B. Tubercle (human). × 1000.
2. B. Tubercle (bovine). × 1000.
3. B. Anthracis. × 1000.
4. Streptothrix actinomyces. × 1000.
5. Staphylococcus pyogenes aureus. × 1000.
6. Streptococcus pyogenes. × 1000.
7. B. Malignant œdema. × 1000.
8. B. Tetanus. × 1000.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requires it and in the way which is most suitable, and he can, therefore, with ordinary care be quite certain that it is not suffering from extraneous sources of contamination. He will take care that all the apparatus which he requires is kept ready to hand so that it can be used at a moment's notice.

How to examine a Liver or Spleen. One or two examples will illustrate best the routine to be pursued. If the specimen under investigation be an internal organ such as liver, spleen, &c., it should be removed from the carcase whole and so transported to the laboratory. All organisms on the surface of the organ must be destroyed either by an antiseptic or a hot instrument, and any incisions made into the tissue must be made with a knife rendered sterile. A good plan when it is desired to ascertain the presence or absence of organisms in the interior portion of a solid organ is to tear the organ a little further than the incision has been carried, taking a portion from this for examination. In this way one is quite certain that nothing has been introduced by manipulation.

How to examine a Fluid. If the investigation is that of a collection of fluid, an abscess for example, other precautions must be adopted. Thus the surface of skin or other tissue under which the abscess lies must be carefully sterilised before the contents are allowed to escape. The cavity containing the fluid being then opened with the sterile knife, the first portion of the contents to escape should be excluded and a portion of that coming later collected in a sterilised test-tube, some of which should always be ready at hand for such purposes. This fluid, whether it be pus or other fluid, can then be examined as described in the preparation of films.

If it be an exudate in the abdominal or thoracic cavities or elsewhere which is the object of investigation, portions of the fluid should be collected by means of sterilised pipettes ; or a length of glass tubing may be used and sealed up by drawing out the ends in the flame if it be required for any length of time before examination.

The inspector will then proceed to make the various preparations upon which his diagnosis will be based. In the first place, he will probably make a dry film, which he will stain in one of the ordinary methods in order to get a general idea of the kind and number of bacteria present. He will then make several plate cultures by the three-tube method, and if time is an important factor in the investigation, he will use for this purpose agar plates in order that they may be incubated. He may also, of course, inoculate nutrient tubes immediately from the suspected material, though in that case he will be less likely to obtain pure cultures. He will then have to await the result of his work until the organisms attain such growth in the nutrient media as will enable him to determine whether he is dealing with a case of mixed infection or only a single organism. In the former case it will be necessary to separate the various cultures from each other, after which all that is necessary is to examine under the microscope by means of a film preparation the organisms thus isolated and to note the cultural characters in the growths obtained.

Information from the Microscope and the Culture. The information which he will gain as to the organism present by means of the microscope is the shape, the size, the reaction to the stain, the presence or absence of a capsule and the presence or absence of spores. Much more information is really forthcoming by observing the characters of the culture. Thus, here will be noted the speed at which it grows at any given temperature, the characteristics of shape and colour of the growth produced, its reaction to the presence of oxygen, the production or otherwise of pigment, gas, or liquefaction, and the situation on the medium of the growth itself, that is to say, whether it appears upon the surface or under the surface. When all these points have been duly noted, together with those afforded by the microscopic examination, the inspector will in most cases have made up his mind as to the character and probably the species of the organism or organisms which have been under investigation.

Various Pathogenic Organisms. It only remains for us here to give a brief description of the characters of those special microbes which are associated with the conditions met with by the meat inspector in which they are the causal agents.

These characteristics will be found to consist of the results which would be obtained by carrying out an investigation on the lines which have just been enumerated.

The organisms which fall to be described are, therefore, those associated with the following conditions: tuberculosis, suppuration, pneumonia, actinomycosis, anthrax, malignant œdema, meat poison, quarter-evil, bacterial necrosis, swine fever, swine erysipelas, braxy, fowl cholera

VARIETIES OF TUBERCULOSIS

(1) **Human and Bovine Tuberculosis.** "Up till recent years it was generally accepted that all mammalian tuberculosis was due to the same organism, and in particular that tuberculosis could be transmitted from the ox to the human subject. The matter became one of special interest owing to Koch's address at the Tuberculosis Congress in 1901, in which he stated his conclusion that human and bovine tuberculosis are practically distinct, and that if a susceptibility of the human subject to the latter really exists, infection is of very rare occurrence—so rare that it is not necessary to take any measures against it. Previously to this, Theobald Smith had pointed out differences between mammalian and bovine tubercle bacilli, the most striking being that the latter possess a much higher virulence to the guinea-pig, rabbit, and other animals, and, in particular, that human tubercle bacilli, on inoculation into oxen, produce either no disease or only local lesions without any dissemination. Koch's conclusions were based chiefly on the result of his inoculations of the bovine species with human tubercle bacilli, the result being confirmatory of Smith's, and, secondly, on the supposition that infection of the human subject through the intestine is of very rare occurrence."

Established Facts on Tuberculosis. "Since the time of Koch's communication, an enormous amount of work has been done on this subject, and Commissions of Inquiry have been appointed in various countries. We may summarise the chief facts which have been established. Practically all observers are agreed that there are two chief types of tubercle bacilli which differ both in their cultural characters and in their virulence —a bovine type and a human type. The bacilli of the bovine type, when cultivated, are shorter and thicker and more regular in size; whilst their growth on various culture media is scantier than that of the human type. From the latter character the British Royal Commission have applied the term *dysgonic* to the bovine and *eugonic* to the human type. As already stated, there is also a great difference in virulence towards the lower animals, the bacillus from the ox having a much higher virulence. This organism, when injected in suitable quantities into the ox, produces a local tubercular lesion, which is usually followed by a generalised and fatal tuberculosis; whereas injection of human tubercle bacilli produces no more than a local lesion, which undergoes retrogression. (In certain experiments, *e.g.*, those of Delépine, Hamilton, and Young, general tuberculosis has been produced by tubercle bacilli from the human subject, but these results are exceptional.) Corresponding differences come out in the case of the rabbit; in fact, intravenous injection of suitable quantities in this animal is the readiest method of distinguishing the two types—an acute tuberculosis resulting with the bovine, but not with the human type. In guinea-pigs and monkeys a generalised tuberculosis may result from subcutaneous injection of bacilli of the human type, but in this case also the difference in favour of the greater virulence of the bovine type is made out. With regard to the distribution of the two types of organisms, it may be stated that so far as we know the bacillus obtained from bovine tuberculosis is always of the bovine type, and the same may be said to be true of tuberculosis in pigs; in fact, this seems to be the prevalent organism in animal tuberculosis. In human tuberculosis the bacilli in a large majority of the cases are of the human type; but, on the other hand, in a certain proportion bacilli of the bovine type are present, the bacilli when cultivated being indistinguishable by any means at our disposal from those obtained from bovine tuberculosis. The Royal Commission found the bovine type in fourteen out of sixty cases of human tuberculosis—a somewhat higher proportion than has been obtained by most other investigators—and in all of these, with one exception, the bacilli were obtained either from caseous cervical glands or from the lesions of primary abdominal tuberculosis, that is, from cases where there was evidence of infection by alimentation. It is also to be noted that almost all the tubercular lesions from which the bovine type has been obtained have been in children. The general result accordingly is that bovine tubercle bacilli are present in a certain proportion of cases of tuberculosis in young subjects, and that these are especially cases where infection by the alimentary canal has occurred. It must thus be held as established that tuberculosis is transmissible

from the ox to man, and that the milk of tubercular cows is a common vehicle of transmission."

Changing Type of Bacilli. "Although most of the bacilli which have been cultivated correspond to one of the two types, as above described, it is also to be noted that intermediate varieties are met with. It has also been found that the type characters of the bacillus are not constant. Various observers have found it possible to modify bacilli of the human type by passing them through the bodies of certain animals, *e.g.*, guinea-pigs, sheep, and goats, so that they acquire the characters of bovine bacilli. In view of these facts, it is probable that bovine bacilli will undergo corresponding modifications in the tissues of the human subject —what period of time is necessary for such a change we cannot say. It is thus possible that the cases from which the bovine type has been obtained do not represent the full number where infection from the ox has occurred. It is quite likely that although the bovine bacilli are more virulent to the lower animals than the human bacilli are, this does not also hold in the case of the human subject. In fact, the comparative chronicity of the primary abdominal lesions in children in the first instance would point rather to a low order of virulence towards the human subject. We may also add that there are cases, notably those of Ravenel, in which accidental inoculation of the human subject with bovine tubercle has resulted in the production of tuberculosis."

(2) **Avian Tuberculosis.** "In the tubercular lesions in birds there are found bacilli which correspond in their staining reactions and in their morphological characters with those in mammals, but differences are observed in cultures, and also on experimental inoculation.

"These differences were first described by Maffucci and by Rivolta, but special attention was drawn to the subject by a paper read by Koch at the International Medical Congress in 1890. Koch stated that he had failed to change the one variety of tubercle bacillus into the other, though he did not conclude therefrom that they were quite distinct species. The following points of difference may be noted."

Points of Distinction and Comparison. "On glycerine agar and on serum the growth of tubercle bacilli from biids is more luxuriant, has a moister appearance, and, moreover, takes place at a higher temperature, 43.5° Cent., than is the case with ordinary tubercle bacilli. Experimental inoculation brings out even more distinct differences. Tubercle bacilli derived from the human subject, for example, when injected into birds, usually fail to produce tuberculosis, whilst those of avian origin very readily do so. Birds are also very susceptible to the disease when fed with portions of the organs of birds containing tubercle bacilli, but they can consume enormous quantities of phthisical sputum without becoming tubercular (Straus, Wurtz, Nocard). No doubt, on the other hand, there are cases on record in which the source of infection of a poultry-yard has apparently been the sputum of phthisical patients. Again, tubercle bacilli cultivated from birds have not the same effect on inoculation of mammals as ordinary tubercle bacilli have. When

guinea-pigs are inoculated subcutaneously they usually resist infection, though occasionally a fatal result follows. In the latter case, usually no tubercles visible to the naked eye are found, but numerous bacilli may be present in internal organs, especially in the spleen, which is much swollen. Further, intravenous injection, even of large quantities of avian tubercle bacilli in the case of dogs, leads to no effect, whereas ordinary tubercle bacilli produce acute tuberculosis. (The rabbit, on the other hand, is comparatively susceptible to avian tuberculosis. Nocard.)

"There is, therefore, abundant evidence that the bacilli derived from the two classes of animals show important differences, and, reasoning from analogy we might infer that probably the human subject also would be little susceptible to infection from avian tuberculosis. The question remains, are these differences of a permanent character? The matter seems conclusively settled by the experiments of Nocard, in which mammalian tubercle bacilli have been made to acquire all the characters of those of avian origin. The method adopted was to place bacilli from human tuberculosis in small collodion sacs containing bouillon, and then to insert each sac in the peritoneal cavity of a fowl. The sacs were left *in situ* for periods of from four to eight months. They were then removed, cultures were made from their contents, fresh sacs were inoculated from these cultures and introduced into other fowls. In such conditions the bacilli are subjected only to the tissue juices, the wall of the sac being impervious both to bacilli and to leucocytes, &c. After one sojourn of this kind, and still more so after two, the bacilli are found to have acquired some of the characters of avian tubercle bacilli, but are still non-virulent to fowls. After the third sojourn, however, they have acquired this property, and produce in fowls the same lesion as bacilli derived from avian tuberculosis. It therefore appears that the bacilli of avian tuberculosis are not a distinct and permanent species, but a variety which has been modified by growth in the tissues of the bird. Evidently also there are degrees of this modification, according to the period of time during which the bacilli have passed from bird to bird, as in some cases inoculation with tubercle bacilli of avian origin has produced ordinary tubercle nodules in guinea-pigs (Courmont and Dor). It is also interesting to note that Rabinowitch has cultivated tubercle bacilli of the mammalian type from some cases of tuberculosis in parrots kept in confinement."

(3) **Tuberculosis in the Fish.** "Bataillon, Dubard and Terre cultivated from a tubercle-like disease in a carp, a bacillus which, in staining reaction and microscopic characters, closely agrees with the tubercle bacillus. The lesion with which it was associated was an abundant growth of granulation tissue in which numerous giant cells were present. It forms, however, luxuriant growth at the room temperature, the growth being thick and moist like that of avian tubercle bacilli. Growth does not occur at the body temperature, though by gradual acclimatisation a small amount of growth has been obtained up to 36° Cent. Furthermore, the organism appears to undergo no multiplication when injected

into the tissues of mammals, and attempts to modify this characteristic have so far been unsuccessful. Weber and Taute have cultivated this organism from mud, and also from the organs of healthy frogs. It is thus probably to be regarded as a saprophyte, which is only occasionally associated with disease in the fish. According to the results of different experimenters it is possible to modify human tubercle bacilli by allowing them to sojourn in the tissues of cold-blooded animals, *e.g.*, the frog, blind-worm, &c., so that they flourish at lower temperatures. These results have, however, been recently called in question, as it has been stated the organisms obtained were not modified tubercle bacilli, but other acid-fast bacilli which may be found in the tissues of normal cold-blooded animals. This question must accordingly be considered still an open one.

"All the above facts taken together indicate that tubercle bacilli may become modified in relative virulence and in conditions of growth by sojourn in the tissues of various animals. This modification appears slight, though of definite character in the case of bovine tuberculosis, more distinct in the case of avian tuberculosis, and much more marked, if not permanent, in the case of fish tuberculosis, that is, of course, in their relations to the bacilli from the human subject." *

ACTINOMYCOSIS

Microscopical Characters. "The parasite, which is now generally regarded as belonging to the streptothrix group of the higher bacteria, presents pleomorphous characters. In the colonies, as they grow in the tissues, three morphological elements may be described, namely, filaments, coccus-like bodies, and clubs.

"(1) The filaments are comparatively thin, measuring about .6 μ in diameter, but they are often of great length. They are composed of a central protoplasm enclosed by a sheath. The latter, which is most easily made out in the older filaments with granular protoplasm, occasionally contains granules of dark pigment. In the centre of the colony the filaments interlace with one another, and form an irregular network which may be loose or dense ; at the periphery they are often arranged in a somewhat radiating manner, and run outwards in a wavy or even spiral course. They also show true branching, a character which at once distinguishes them from the ordinary bacteria. Between the filaments there is a finely granular or homogeneous ground substance. Most of the colonies at an early stage are chiefly constituted by filaments loosely arranged ; but later, part of the growth may become so dense that its structure cannot be made out. This dense part, starting excentrically, may grow round the colony to form a hollow sphere from the outer surface of which filaments radiate for a short distance. The filaments usually stain uniformly in the younger colonies, but some, especially in the older

* Muir and Ritchie, "Manual of Bacteriology."

colonies, may be segmented so as to give the appearance of a chain of bacilli or of cocci, though the sheath enclosing them may generally be distinguished. Rod-shaped and spherical forms may also be seen lying free."

(2) **Spores or Gonidia.** "Like other species of streptothrix the actinomyces, when growing on a culture medium, shows on its surface filaments growing upwards in the air, the protoplasm of which becomes segmented into rounded spores or gonidia. In natural conditions outside the body these gonidia become free and act as new centres by growing out into filaments. They have somewhat higher powers of resistance than the filaments, though less than the spores of most of the lower

ACTINOMYCOSIS (RAY FUNGUS)

bacteria. An exposure to 75° Cent. for half an hour is sufficient to kill most streptothrices or their spores ; cultures containing spores can resist a temperature from five to ten degrees higher than spore-free cultures (Foulerton). It is probable that some of the spherical bodies formed within filaments when growing in the tissues have the same significance, *i.e.*, are gonidia, whilst others may be merely the result of degenerative change. Both the filaments and the spherical bodies are readily stained by Gram's method."

(3) **Clubs.** "These are elongated pear-shaped bodies which are seen at the periphery of the colony, and are formed by a sort of hyaline swelling of the sheath around the free extremity of a filament (*see* above). They are usually homogeneous and structureless in appearance. In the human subject the clubs are often comparatively fragile structures, which are easily broken down, and may sometimes be dissolved in water. Sometimes they are well seen when examined in the fresh condition, but in hardened specimens are no longer distinguishable. In specimens stained by Gram's method they are usually not coloured by the violet, but take readily a contrast stain, such as picric acid, rubin, &c ; sometimes a darkly stained filament can be seen running for a distance in the centre, and may have a knob-like extremity. In many of the colonies in the human subject the clubs are absent. In the ox, on the other hand, where there are much older colonies, the clubs constitute the most

prominent feature, whilst in most colonies the filaments are more or less degenerated, and it may sometimes be impossible to find any.

"They often form a dense fringe around the colony, and when stained by Gram's method retain the violet stain. They have, in fact, undergone some further chemical change which produces the altered staining reaction. Occasionally, in very chronic lesions in the human subject, the clubs stain with Gram's method. Clubs showing intermediate staining reaction have been described in the ox by M'Fadyean. The club-formation probably represents a means of defence on the part of the parasite against the phagocytes of the tissue; the view, formerly held, that the clubs are organs of fructification has now been generally abandoned" ("Manual of Bacteriology," Muir and Ritchie).

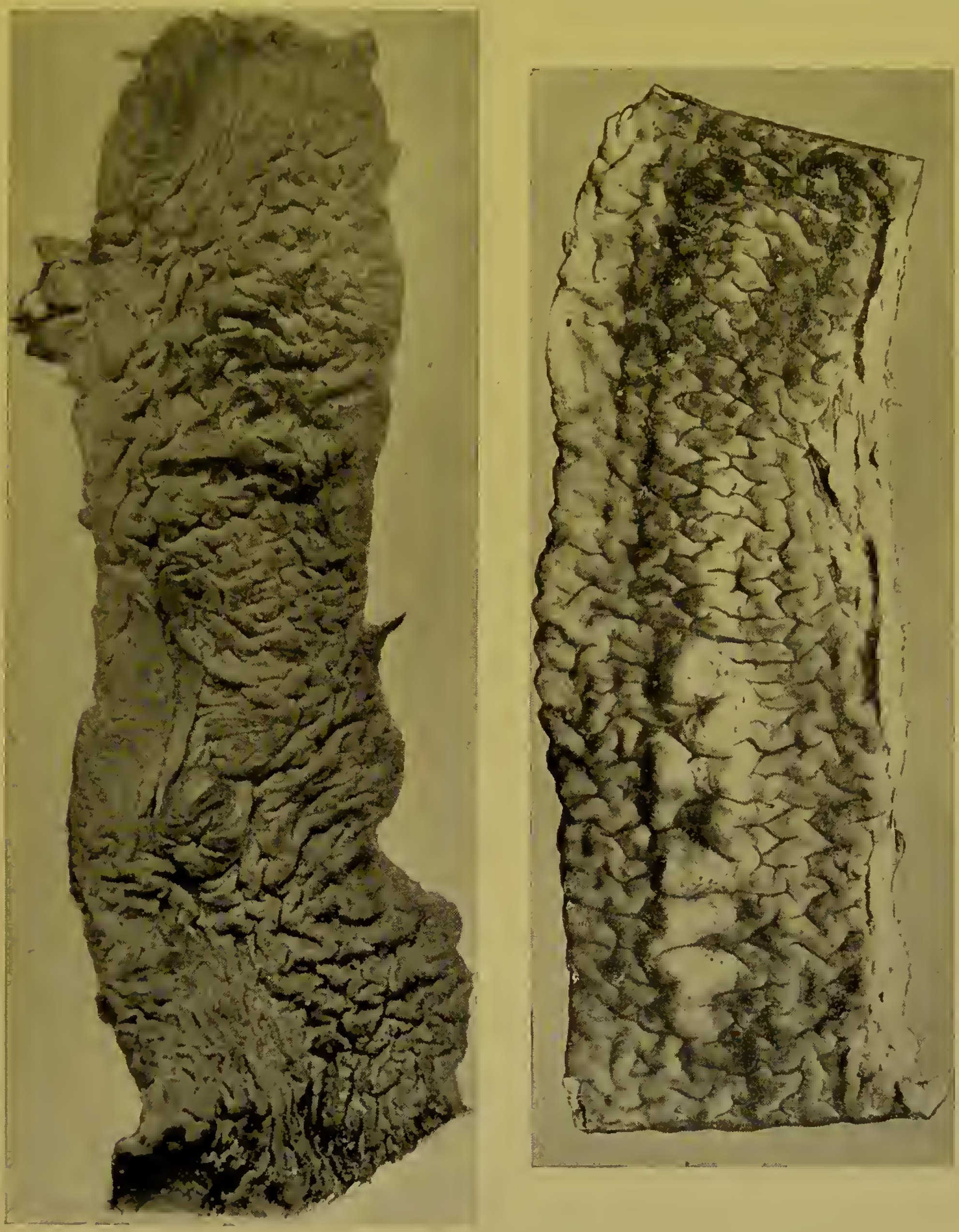
Johne's Disease. This condition, which is sometimes referred to as chronic bovine pseudo-tuberculous enteritis, has been observed in various countries. British cases have been recorded by Sir John M'Fadyean, and one came under the notice of the present writer in a cow at the Edinburgh slaughterhouse in October 1909. The coloured plate of the condition was painted from the case in question (Plate XXVIII.). As will be seen in that illustration, and also in the photograph taken from the same case (p. 1075) the lesions produced take the form of great thickening and corrugation of the mucous membrane of the small intestine, which is everywhere thrown into well-marked rugæ or folds. There is some slight congestion, which, however, is not a marked feature. In the writer's case, as in most, the specific organisms, Johne's bacilli, were found in great numbers in a smear taken from the surface of the mucous membrane.

Johne's Bacillus. This bacillus is of interest because it is one of the few bacilli that are acid-fast, resembling the tubercle bacillus in that respect. The bacillus of Johne's disease is, however, a little shorter than that of tuberculosis. It produces a chronic enteritis in cattle, a few cases of which are recorded from time to time in this country, and in these cases the bacilli occur in great numbers in the small intestine. The condition is sometimes referred to as chronic bovine pseudo-tuberculous enteritis.

Pseudo-tuberculosis (*Lympho-adenitis*). The following account of the organism which is found associated with this condition in New Zealand, where it is a common affection, is taken from the magazine of the Agriculture Department, N.Z. (by permission of the New Zealand Government):

"The specific organism is a short irregular-shaped bacillus, varying in size and appearance from a coccus to a very short bacillus, *i.e.*, from 0.5 to 1 micron in length and about 0.3 in breadth. In the pus of an early abscess the bacilli are frequently within more or less degenerated leucocytes, especially those in scrapings from near the periphery of the abscess or the lining of the fibrous capsule (*see* Plate XXXI.). In the centre of an old abscess the bacilli are usually very degenerated and irregular, occasionally being quite absent. Frequently the organisms are found

in pus in chains which may almost be mistaken for streptococci, though careful examination demonstrates that these chains are composed of short cocco-bacilli extremely small even in their longest diameter, and arranged side by side, not end to end. The bacilli are readily stained by



JOHNE'S DISEASE OF BOVINE INTESTINE

the method of Gram. When pus is stained by a simple stain such as methylene-blue, thionine, or weak fuchsin, they are with difficulty observed consequent upon their small size. The best method of demonstration is to stain pus by Gram's method and counterstain with eosin or weak fuchsin.

Growth in Media. " *Serum Cultures.* The bacilli grow most readily and exhibit the most distinctive characteristics on solidified clear ox-blood serum. Separate colonies appear after twenty-four hours at 37° Cent. as small greyish points. These gradually increase in size for the

next two days, when they reach the diameter of 3 mm., assuming a distinctly yellowish tint, have a raised darker centre and irregular edge. The distinctive characteristic, however, is not observed on examining the colonies on the free surface of the serum-slope. If examined through the clear solidified serum a yellow feathery zone is found to radiate from the edge of the colony into the substance of the serum and on each side of the surface-growth. This zone or aureole is very peculiar and striking. Naturally it is only to be observed in carefully prepared serum which is sufficiently clear to be transparent. Streaks on slope serum show a thin, slightly yellowish growth with irregular borders after twenty-four hours at 37° Cent. It is rarely till the second or even the third day that the characteristic zone makes its appearance. The breadth of the streak culture gradually increases, but, as a rule, never exceeds 4 mm. The aureole, however, increases till practically the whole of the serum is occupied by the growth (*see* Plate XXXI.). In the condensation liquid growth takes place readily, the liquid becoming rapidly cloudy with a dirty yellowish white appearance and a considerable dense yellow deposit at the bottom. In subcultures on serum incubated at 37° Cent. a faint growth can be observed six hours after inoculation. In liquid serum the bacillus grows very readily. A flocculent yellow scum forms on the surface, and in two days reaches a thickness of 2 mm. The rest of the serum remains cloudy and of a whitish yellow tinge, with a large yellow deposit at the bottom of the liquid. If the tube be shaken the yellow scum can be easily mixed with the fluid, but much gradually returns to the surface. The bacilli, when grown on serum, assume the form of cocco-bacilli, generally in pairs, slightly shorter and narrower than those found near the wall of an abscess, but may vary from almost a coccus to a bacillus nearly as long as that of typhoid.

"In sheep-serum the growth is entirely distinct to that on ox-serum, there being no pigmentation. The growth is greyish white, and the definite feathery zone of the ox-serum is absent or barely observable. In liquid serum growth is very rapid, and similar to that already described in liquid ox-serum, with the exception that the colour is a greyish white.

"*Broth Cultures.* If carefully inoculated, after twenty-four hours a thin scum may be observed on the surface of the liquid, with a powdery deposit on the sides and at the bottom of the tube. This scum is generally irregular on the surface, and readily broken down into a flocculent mass, little of which returns to the surface on settling. If another tube be inoculated with a portion of the scum it rapidly grows, and no turbidity of the broth is produced. If broth be inoculated in the depth, little or no scum is produced. A very faint turbidity is apparent twenty-four hours after inoculation, but this soon clears, leaving only a deposit at the bottom of the tube and a faint powdery mass adherent to that side which is lowest on the plane of the slope, while the liquid remains clear. A broth culture examined under the microscope shows the bacilli in masses or rows, which are apparently difficult to break. When in rows the bacilli look not unlike very small streptococci, but careful examination

shows each organism to have a long and narrow diameter, the bacilli lying side by side, as it were, and not end to end.

"*Agar Cultures.* On ordinary agar I found it difficult at first to secure any growth when inoculated in the ordinary way with pus by means of a needle. After sub-cultures were made on serum, however, a good growth could be obtained on slope agar. The growth, after twenty-four hours, consists of a thin powdery-looking streak, with irregular borders. On agar subcultures, again, the growth increases slightly in breadth and thickness, its borders showing the irregular crenated appearance characteristic of cultures of this organism. The colonies appear as greyish white points with raised centre, and do not attain the maximum size for ten or twelve days, when they are from 4 mm. to 6 mm. in diameter, with crenated borders. In streak-agar subcultures the growth after the lapse of a week consists at 37° Cent., when viewed through the slope agar, of a narrow central grey-brown line, on each side of which is a zone of a thick white growth, external to which is a zone of semi-transparent growth with distinctly crenated borders.

"In all cultures the growth is very tenacious and cohesive, under the microscope the bacilli generally appearing in masses, or chains. The bacillus, when grown on agar or glycerine agar, is very short, almost resembling a streptococcus both in size and arrangement, and at times is almost indistinguishable from cocci with an ordinary one-twelfth oil-immersion lens. When very carefully examined, however, it is seen to be somewhat longer than appears at first sight.

"Glycerine agar as a medium is not favourable, the growth being not so characteristic or so distinct as on ordinary agar.

"In *gelatine* at room-temperature, a growth, very fine and with no characteristic appearances, is visible in about five to eight days. It grows equally well in slope or stab culture.

"On *potato*, either ordinary or with glycerine, I have not succeeded in securing any growth.

"In *milk* the bacillus grows readily at 37° Cent., forming a thick brownish deposit at the bottom of the tube. The milk is not altered in reaction, as shown by cultures made in litmus milk. The bacilli are found in groups, and are very short, being in certain cases almost indistinguishable from cocci."

Experiments. "*Sheep* 1. Inoculated in thigh with 0.1 c.c. pus from a precrural lymph-gland forwarded by Mr. Rait.

"Practically no evidence of discomfort beyond a very slight lameness for the first two days was noticed in this animal. The animal remained in good condition, and was killed four months later.

"*Post-mortem Examination.* At original seat of inoculation a small mass of greenish caseous matter was present surrounded by a fibrous capsule about ¼ in. thick. The popliteal, precrural, and pelvic glands of the same side were enlarged and caseous, with the usual capsule surrounding the central caseous greenish mass of degenerated material. Other lymphatic glands of the body normal. Lungs: Under the pleuræ

of both lungs were a number of nodules varying from the size of a pea to that of a marble, of a greenish translucent tint when fresh, and surrounded by a purple zone. On collapse of the lung these nodules became more prominent (*see* Coloured Plate of Lung—much reduced). Throughout the lung-tissue generally a number of similar nodules were present, but the greatest number were situated just underneath the pleura. Each nodule consisted of a greenish caseous centre surrounded by a thick fibrous wall, which gradually merged into healthy lung-tissue. There was no pleurisy, and the thoracic lymphatic glands were healthy. From the glands and lung the characteristic organism was isolated.

"*Sheep* 2. Inoculated in flank with 0.5 c.c. three-days-old culture in serum condensation liquid.

"Next day the animal was carrying the inoculated leg, and showing slight swelling and inflammation at seat of inoculation. The following morning she was found lying on her side dead, with blood-tinged froth issuing from the nostrils.

"*Post-mortem Examination.* Animal in good condition; small quantity of subcutaneous œdema at seat of inoculation. The spleen was enlarged and pulpy, the contents being of a tarry consistency. The alimentary tract was filled with ingesta. The abomasum exhibited on its mucous surface small patches of inflammation, each with its centre slightly ulcerated. The pleural cavity contained about a quart of sero-sanguineous effusion. The kidneys were slightly congested. Other organs normal.

"*Microscopical examination* of smears disclosed no organisms in any of the tissues, beyond a large number present in the subcutaneous œdema at the seat of inoculation, and these chiefly within leucocytes. Pipettes containing spleen-pulp, pleural effusion, and blood were placed at 37° Cent., but did not develop the characteristic bacillus, while serum-tubes inoculated with the same material remained sterile. Tubes inoculated with the subcutaneous effusion developed the characteristic growth of the bacillus in a state of purity."

Bacillus Botulinus. "The term 'meat-poisoning' embraces a number of conditions produced by different agents, and the relation of the bacillus of Gaertner to one class of case has already been discussed. Another group was shown by van Ermengem in 1896 to be caused by an anærobic bacillus to which he gave the name *Bacillus botulinus.* He cultivated the organism from a sample of ham, the ingestion of which in the raw condition had produced a number of cases of poisoning, some of them followed by fatal result. The symptoms in these cases closely corresponded with those occurring in the so-called 'sausage poisoning' met with from time to time in Germany and other countries where sausages and ham are eaten in an imperfectly cooked condition. Such cases form a fairly well-defined group, the symptoms in which are chiefly referable to an action on the medulla, and, as will be detailed below, similar symptoms have been experimentally produced by means of the bacillus mentioned or its toxins. The chief symptoms of this variety of *botulismus*,

as detailed by van Ermengem, are disordered secretion in the mouth and nose, more or less marked ophthalmoplegia, externa and interna (dilated pupil, ptosis, &c.), dysphagia, and sometimes aphagia with aphonia, marked constipation and retention of urine, and in fatal cases interference with the cardiac and respiratory centres. Along with these there is practically no fever and no interference with the intellectual faculties. The symptoms commence at earliest twelve to twenty-four hours after ingestion of the poison. From the ham in question, which was not decomposed in the ordinary sense, van Ermengem obtained numerous colonies of this bacillus, the leading characters of which are given below. It may be added that Romer obtained practically the same results as van Ermengem in a similar condition, and that the *Bacillus botulinus* has been cultivated by Kempner from the intestine of the pig."

Microscopical and Cultural Characters. "The organism is a bacillus of considerable size, measuring 4 to 9 μ in length and .9 to 1.2 μ in thickness; it has somewhat rounded ends and sometimes is seen in a spindle form. It is often arranged in pairs, sometimes in short threads. Under certain conditions it forms spores which are oval in shape, usually terminal in position, and a little thicker than the bacilli. It is a motile organism and has 4 to 8 lateral flagella of wavy form. It stains readily with the ordinary dyes, and also retains the colour in Gram's method, though care must be employed in decolorising.

"The organism can be readily cultivated on the ordinary media, but only under strictly anærobic conditions. In glucose gelatine a whitish line of growth forms with lateral offshoots, but liquefaction with abundant gas-formation soon occurs. In gelatine plates the colonies after four to six days are somewhat characteristic; they appear to the naked eye as small semi-transparent spheres, and these on examination under a low power of the microscope have a yellowish brown colour and are seen to be composed of granules which show a streaming movement, especially at the periphery. Cultures in glucose agar resemble those of certain other anærobes; there is abundant development of gas, and the medium is split up in various directions. The cultures have a rancid, though not foul, odour, due chiefly to the development of butyric acid. The optimum temperature is below that of the body, viz., between 20° and 30° Cent.; at the body temperature growth is slower and less abundant and spore-formation does not occur" ("Manual of Bacteriology," Muir and Ritchie).

Bacteriology of Meat-poisoning. Professor E. J. McWeeney, of Dublin, published in the *British Medical Journal* (May 15, 1909) a summary of his investigations into an outbreak of meat-poisoning at Limerick in an industrial school. The cases numbered 73, of which 9 terminated fatally. The following paragraphs from this summary deal with the bacteriological results:

"From practically all of the viscera examined, as well as from the discharges obtained from the recovering cases, I succeeded in isolating either by direct culture or after preliminary enrichment in malachite-green broth, a typical strain of the *Bacillus enteritidis* of Gaertner. The

medium used for plating out was Drigalski's litmus-nutrose-lactose-crystal-violet-agar. On it the Gaertner colonies were readily distinguishable by their bluish translucent appearance, vigorous growth, and marked tendency to become confluent. The same colonies were obtained from all three cases examined post-mortem. Avoiding technical details, I will merely say that morphologically this organism is identical with the typhoid bacillus and is quite as actively motile. It differs from the typhoid bacillus, *inter alia,* in its more rapid growth on gelatine, its ability to clear up milk, and to ferment glucose with formation of acid and gas. It differs from an actively motile strain of *B. coli* in the delicate character of its gelatine colonies, its inability to coagulate milk, to ferment lactose, and to form indol. I could find no constant morphological or cultural difference between this strain of Gaertner's bacillus and the paratyphoid *B. bacillus* (two strains isolated by myself from Irish cases). Neither does it seem to differ morphologically or culturally from the bacillus of Ratin.

"Serologically, however, it stands nearer to typhoid than to paratyphoid B., and by comparative agglutination tests I find it to belong to the true Gaertner type (that responsible for the outbreaks of food-poisoning at Rumfleth, Haustadt, Morseele, &c., described by van Ermengem and his pupils) and not to the morphologically identical, but serologically distinct, 'Flugge-Kaensche' or 'Aertryke' type."

Summary and Conclusions. "This severe outbreak of meat-poisoning was caused partly by intoxication (*cf.* the short incubation period), and partly by infection (*cf.* the cultivation of the organism from the three fatal and two of the recovering cases). The causal micro-organism was the genuine *Bacillus enteritidis* of Gaertner, which must have been conveyed to the sufferers in the beef; and from the history it seems probable that the calf was sickly, and already harboured the bacillus at the time of slaughter. The escape of those who partook of portions of the same carcase on October 27 and 29 may be accounted for either by unequal distribution of the virus, or by thorough cooking which destroyed it. Some of the infective material must, however, have escaped the roasting of the 29th, and, multiplying rapidly, have rendered the whole piece intensely toxic and infective during the five days that elapsed before the fatal Tuesday when it was finally consumed. The practical lesson to be derived from the observation of this occurrence—the most disastrous of its kind hitherto recorded, so far as the writer knows—is twofold. First, it indicates the need there is for the abolition of the private slaughterhouse, and for the inspection of all animals used for human food, both before, during, and after slaughter; secondly, it emphasises the danger arising from the use of old stale scraps of meat, and especially of beef. If, on economic grounds, such left-over pieces *must* be used up, the only way of avoiding or diminishing the danger would seem to be very thorough and prolonged boiling. Ordinary examination of such meat may fail to discover any grounds for suspicion."

Bacteriology of Canned Meats. In the examination of suspected or condemned samples of canned meats the following procedure is the one that may be satisfactorily adopted. The surface of the tin must be thoroughly sterilised before it is punctured with a view of extracting a sample. This sterilising must be done by sponging the surface with corrosive sublimate (one in a thousand) after which a little methylated spirit may be poured upon the tin and set alight.

If convenient, the naked flame of a Bunsen burner may be allowed to play on the surface of the tin for a period sufficient to kill any organisms that might be there. The suspected can is then punctured by means of some sharp-pointed sterilised metal instrument and a small sterile pipette is inserted through the opening, care being taken to pass it well into the contents of the can. In withdrawing the pipette suction is applied and in this way a small quantity of the contents is extracted. The outer portion of the lumen of the pipette may be plugged with cotton-wool to prevent contamination. From the substance, whether solid or liquid, thus withdrawn from the interior of the can, the bacteriological examination is made in the way described on another page (*see* p. 1067).

As soon as the plates or cultures have sufficiently developed, films are prepared and the microscopic examination of the bacteria present is undertaken.

Where organisms are present in these unsound tins of canned meat they have been found to consist chiefly of bacilli and micrococci. The bacilli included *Bacillus subtilis*, *B. proteus vulgaris*, and *B. coli communis*. The micrococci are chiefly those of *Staphylococcus pyogenes albus* and *citreus*.

The conclusion is therefore arrived at that these defective cans contain bacteria as the result of the action of which fermentative or putrefactive changes are induced in the contents of the can, and that the distention of the cans is due to the formation of gases caused by the microbes within.

BRAXY

The Organism. " The merit of having thrown the first light upon the ætiology of the disease is due to Ovar Nielsen. In his work on the subject, published in the year 1888, he described an organism which he found in the hæmorrhagic areas of the digestive tract, as well as in the capillaries of the various organs, which is, without doubt, the essential factor in the disease. The organism in question is a rod from 2 to 6 μ long or longer, and about 1 μ in breadth, with rounded ends. I have sometimes found it, in cultures at least, elongating into a thread, but, in the tissues, it usually takes the rod form. It retains the stain by Gram's method, and more readily when quite freshly removed from the body ; it is perfectly immobile, both when taken immediately from the various serous effusions or the blood and when in culture. As it occurs in the various liquids of the animal, it has a great tendency to spore, often nearly every rod being in this condition. The spore is usually placed at

one end of the rod, and when developing gives to this end merely an appearance of being thicker than the other, while, with careful focussing, a clear, minute and highly refractile point may be detected in the midst of the tuberosity. As the spore enlarges it becomes more and more refractile, and takes on an elongated oval shape, and in this stage the organism has a characteristic drumstick appearance very like that of tetanus. Sometimes the spore is located in the middle of the rod, and I have seen, occasionally, a couple of spores of large size in a single bacillus, one at each end. The individual bacilli may be either united at an agle when in juxtaposition, or their axes may lie parallel and in line, in which case they may resemble a single bacillus of unusually great length. Exceptionally they may hang in rows, but this is not common. In certain instances of the disease the spores are present only in small number, or may even be absent, and in such cases the virus appears to confer a mild attack. At any rate, I have often found difficulty in inoculating the disease and producing a fatal issue when the organism is in this non-sporing condition.

"It seems to be a strict anaerobe, at least when first removed from its natural habits. It is extremely difficult to isolate by means of plate cultures if there be the slightest trace of oxygen in the surrounding atmosphere. The method which, in my hands, has proved most successful is the following: Take the virus from a case in which the organism is sporing profusely. Use a medium composed of peptonised beef-tea with 2 per cent. glucose, and be careful that the medium has a faint, but a quite decided, acid reaction to litmus. Boil the medium for half an hour before inoculating it, and while it is boiling, or as soon as possible afterwards, inoculate it with some of the serous effusions of the body, preferably the peritoneal liquid. The chief organism of contamination is *Bacillus coli*, and I have never failed to kill this off by the high temperature of the medium. Close the mouth of the tube immediately thereafter with a well-fitting caoutchouc cap, and keep the medium at a temperature of 37° C. I prefer this to all the methods of anærobic culture I have used for isolating the organism. Within a few hours gas begins to be given off copiously, which escapes between the cap and the side of the tube, while the cap contracting makes an excellent valve. At the end of forty-eight hours gas-formation has ceased, and the organism falls down, in the shape of a fine greyish-coloured precipitate, to the bottom of the tube, or, if the tube has been in a sloping position, adheres to the lowest side. It seems to grow comparatively little after the time when gas ceases to be evolved, and from this time onwards will generally be found to be sporing.

"Other media can be employed for its culture, but in none of them, it seems to me, is the appearance of the growth so characteristic as in the above. Thus it will grow in agar or serum-agar readily enough, the growth in agar being, however, slower than in other media. The addition of 2 per cent. glucose to any of these media increases their usefulness. Gelatine is not a favourable medium, although the organism will grow in it.

"In some of the accounts I have read of the cultivation of the organism in this medium the virus appeared to have been contaminated with *B. coli*.

"Where inoculated pure on glucose-agar a luxuriant growth rapidly shows itself along the track of the needle up to within 1 to $1\frac{1}{2}$ centimetre from the surface. There is never a particle of growth on the free surface if the atmosphere within the tube contains oxygen. Copious gas-bells are given off, which soon tear the medium in pieces and force it up against the cotton-wool plug. If the disengagement of gas is slight, mere slits or tiny rents may be formed in the medium, along which the bacillus tends to propagate.

"For inoculation purposes, I find the organism taken from the peritoneal liquid the best to work with grown in glucose beef-tea as above described. By the end of forty-eight hours the growth is in the best condition for inoculating. At a later period, and in proportion apparently with the time, the virulence of the organism becomes less and less; but a good deal seems, as with other bacteria, to depend upon whether it is sporing or not. The spores are peculiarly tenacious of life. Thus Jensen found that after the stomach of a braxy sheep had been kept in dilute spirit, even for a period of seven weeks, he was still able to get a growth from it.

"The organism of braxy is apparently very closely related to that of quarter-evil and of malignant œdema. The three form a group which stand isolated, and which have intimate mutual relationships. In fact, when growing in solid media there is much difficulty in distinguishing them. Its complete immobility seems to me one of the best features by which the braxy bacillus can be distinguished from the other two. According to Jensen, the braxy bacillus is also to be distinguished from that of quarter-evil by the fact that it is pathogenic to mice, pigeons, fowls, and pigs, animals which are insusceptible to quarter-evil. It is a remarkable fact, however, that these animals never take the disease naturally, nor has the disease ever been known to affect the cow, the dog, or man. I have seen dogs and fowls eating raw braxy flesh over and over again, but even after the strictest inquiry, I have never been able to make out that these animals contract the disease by doing so, nor under any other circumstances. The sheep seems to be the only animal which is naturally subject to it" (J. McLauchlan Young).

Bacteriology of Meat in Emergency Cases. Much of our knowledge on the bacteriology of these cases is due to the brilliant work of Basenau, who suggests that bacteriological examination should be carried out in the following manner and judgment arrived at according to the result stated :

"It is desirable that the investigation be undertaken twenty-four hours after ordinary or emergency slaughter, for the reason that the bacteria of meat-poisoning multiply even at low temperatures, and the large numbers which are thus obtained facilitate investigation. In this connection it is naturally supposed that after slaughter the stomach,

intestines, &c., are removed in the usual manner. We thus exclude the possibility that bacteria which may be found in the interior of the meat have made their way thither as a result of post-mortem invasion from the intestines. For, according to manifold experience, no micro-organisms are found in the meat of healthy animals even when examined a long time after slaughter. Streak cultures and gelatine plate cultures are then to be prepared from the inside of a piece of meat which contains much loose connective tissue. Gelatine plates are quite satisfactory for this purpose, provided one uses Forster's gelatine with a high liquefaction point. Simultaneously, two mice should be fed with pieces of raw meat and two others with pieces of meat which have been subjected for one hour to a temperature of 100° Cent.

"If micro-organisms are not found in the preparations and if no colonies develop in the plates within twenty-four hours, the meat can be discharged without further investigation.

"If the presence of bacteria is demonstrated in the streak cultures or plates, the meat should be preserved temporarily in a suitable manner and the result of the animal experiment, which should be manifest in most cases within at most three days, if the result is positive, will assist in rendering the final judgment. If the mice which are fed with the raw meat die, while those which are fed with meat cooked for one hour do not die, it is apparent that the poisonous property is removed by cooking. According to previous experience, the meat may then be admitted to the market without any danger to human health, after a previous sterilisation in a steam apparatus. If no apparatus for sterilisation is available, then the simple demonstration of the presence of large quantities of bacteria in the meat is sufficient to justify condemnation. If the animals fed on the pieces of boiled meat also die, the meat is to be excluded from the market, or at least admitted only for technical purposes. This procedure would be in the spirit of the recommendations of Gerlach, who, several decades ago, stated that the aim of meat inspection should be to protect the health of the consumers and at the same time to utilise as much as possible of the abnormal food animals." (Ostertag.)

It is not absolutely necessary to use the plate cultures referred to in the above paragraph ; it will be sufficient to carry out the procedure which we have already described on a previous page by making sloping cultures on agar.

ZIEHL NEELSEN METHOD FOR STAINING TUBERCLE BACILLI

(1) Stain with carbol fuchsin, heating gently until steaming. Leave for five minutes, or allow specimen to remain in carbol fuchsin cold for 12 to 24 hours.

(2) Decolorise with 20 per cent. solution of sulphuric acid in water. (The specimen becomes yellow.)

(3) Wash well in water. Tissue should regain a very faint pink colour.

TABULATED SUMMARY OF THE CHIEF CHARACTERS OF PRINCIPAL PATHOGENIC MICROBES

Species.	Shape.	Size in micro-millimetres.	Spores.	Reaction to Gram's stain.	Reaction to gelatine.	Optimum temperature.	Reaction to oxygen.
Actinomycosis	Streptothrix	Filaments .6 in diameter	Present as gonidia	Positive	Liquefies slowly	37° C.	Almost anaerobic
Anthrax	Bacillus	1.2 × 6–8	Present in free oxygen	Positive	Liquefies 24–36 hours	37° C.	Facultative anaerobe
Tubercle, human	Bacillus	·3 × 2.5–3·5	Doubtful	Acid-fast	Grows on serum	37° C.	Aerobe
Tubercle, bovine	Bacillus	Shorter, thicker	Doubtful	Acid-fast	Grows easier	37° C.	Aerobe
Tubercle, avian	Bacillus	As bovine	Doubtful	Acid-fast	Still easier	Higher	Aerobe
Glanders	Bacillus	Length as T.B.	Doubtful	Negative	Best on potato	35°–37° C.	Aerobe
Tetanus	Bacillus	·4 × 4–5	Present	Positive	Liquefies slowly	37° C.	Anaerobic
Malignant œdema	Bacillus	1 × 3–10	Present	Negative	Liquefies with gas	37° C.	Anaerobic
Botulinus	Bacillus	1 × 4–9	Present, oval	Positive	Liquefies with gas	20°–30° C.	Anaerobic
Black quarter	Bacillus	1 × 3–10	Present	Negative	Liquefies	37° C.	Anaerobic
Staphylococcus pyogenes aureus	Coccus	·9	Absent	Positive	Liquefies	Ordinary	Aerobe
Staphylococcus pyogenes albus	Coccus	·9	Absent	Positive	Liquefies slowly	Ordinary	Aerobe
Streptococcus pyogenes	Coccus	1	Absent	Positive	Does not liquefy	7° C.	Aerobe
Bacillus pyocyaneus	Bacillus	·5 × 1.5–3	Absent	Negative	Liquefies with green tint	Ordinary	Aerobe
Pneumo-bacillus	Very short rod	1 × 1.5	Absent	Negative	Does not liquefy	37° C.	Aerobe
Swine fever	Bacillus	.6 × 1.2	Absent	Negative	Does not liquefy	37° C.	Facultative anaerobe
Swine erysipelas	Bacillus	.2 × .8–1.5	Absent	Positive	Does not liquefy	Ordinary	Aerobe

BACTERIOLOGY. ARRANGED BY W. J. MOODY, F.R.C.V.S.

Disease.	Anthrax.	Tetanus.	Malignant œdema.	Black quarter.	Swine fever.	Swine erysipelas.
Habit of life	Facultative parasite	Facultative parasite	Facultative parasite	Facultative parasite	Obligatory parasite	Facultative parasite
Distribution	Septicæmic	Tissue	Tissue	Tissue	Tissue	Septicæmic or tissue
Cultural characters	Strict aerobe	Anaerobe	Anaerobe	Anaerobe	Aerobe	Facultative aerobe
Limits of growth (Centigrade)	16–44	14–	16–			16
Optimum (Centigrade) temperature	37	37	37	37	37	37
Shape of organism	Rod-shape	Rod-shape	Rod-shape	Rod or oval	Rod-shape	Cylindrical
Length	4 μ	4–5 μ	4 μ	3–4 μ	1–2 μ	2–3 μ
Breadth	1.5 μ	.4 μ	1 μ	Less than 1 μ	.6 μ	.3 μ
Stain by Gram	Positive	Positive	Negative	Negative	Negative	Positive
Sporulating temperature	18–42		70–100			Does not sporulate
Animals attacked	M.C.H.S.P.D.	M.H.C.S.P.D.C.	H.S.P.D.	Ox and sheep	Pig only	Pigs

BACTERIOLOGY. ARRANGED BY W. J. MOODY, F.R.C.V.S.

Disease.	Contagious pneumonia of pig.	Tuberculosis.	Fowl cholera.	Actinomycosis.	Staphylococcus pyogenes aureus.	Discomyces.
Habit of life	Facultative parasite	Obligatory parasite	Facultative parasite	Facultative parasite	Facultative parasite	Facultative parasite
Distribution	Tissues	Tissues	Septicæmia	Tissues	Tissues	Lesions
Cultural characters	*See* Fowl cholera	Aerobic	Aerobic	Aerobe	Aerobe	Aerobe
Limits of growth		32–42° C.	Ordinary temperatures			
Optimum		37° C.			37° C.	37° C.
Shape of organism		Rod-shape	Short rod, round ends	(1) Streptothrix (2) Clubs (3) Coccus-like	Spherical	Spherical
Length		3 u	1–2 by .5		·5 μ	·5 μ
Breadth		·3 μ	·5 μ		5 μ	·5 μ
Stain by Gram ?		Negative	Gram negative	Positive	Positive	Positive
Sporulating temperature		Does not sporulate	Polar staining		Does not sporulate	Does not sporulate
Animals attacked	Pig	M.H.C.P.S.D.C. and B.	Fowl, rabbit, swine, &c.	C. P.	All	Horse

M = Man, C = Cattle, H = Horse, S = Sheep, P = Pig, D = Dog, C = Cat, B = Birds.

(4) Wash in alcohol for half a minute. Replace in water.

(5) Counterstain with saturated watery solution of methylene-blue or Bismarck-brown for 2 or 3 minutes.

(6) Wash well (dehydrate, clarify, mount, if sections) dry, and mount film.

GRAM'S STAINING METHOD

For Films.

(1) Dry and fix film. Filter on aniline-gentian-violet. Leave for five minutes.

(2) Pour on Gram's iodine solution, without washing. Two minutes exactly.

(3) Place cover-slip in alcohol, until no more violet colour comes away. (The film is not absolutely decolorised thus.) Time: five minutes or more according to thickness.

(4) Wash in water, dry, mount in xylol Canada balsam.

For pus, sputum, &c., counterstain after washing (*see* (4)).

FREEZING-MIXTURE FOR MICROTOME

Take about a pint of water and boil it in a pan. Then add about an ounce of gum acacia and stir until it is dissolved. Add to this two tablespoonfuls each of boracic acid and sugar. Filter the mixture through muslin twice. Then allow it to stand overnight and filter it again twice through muslin.

END OF VOLUME III.